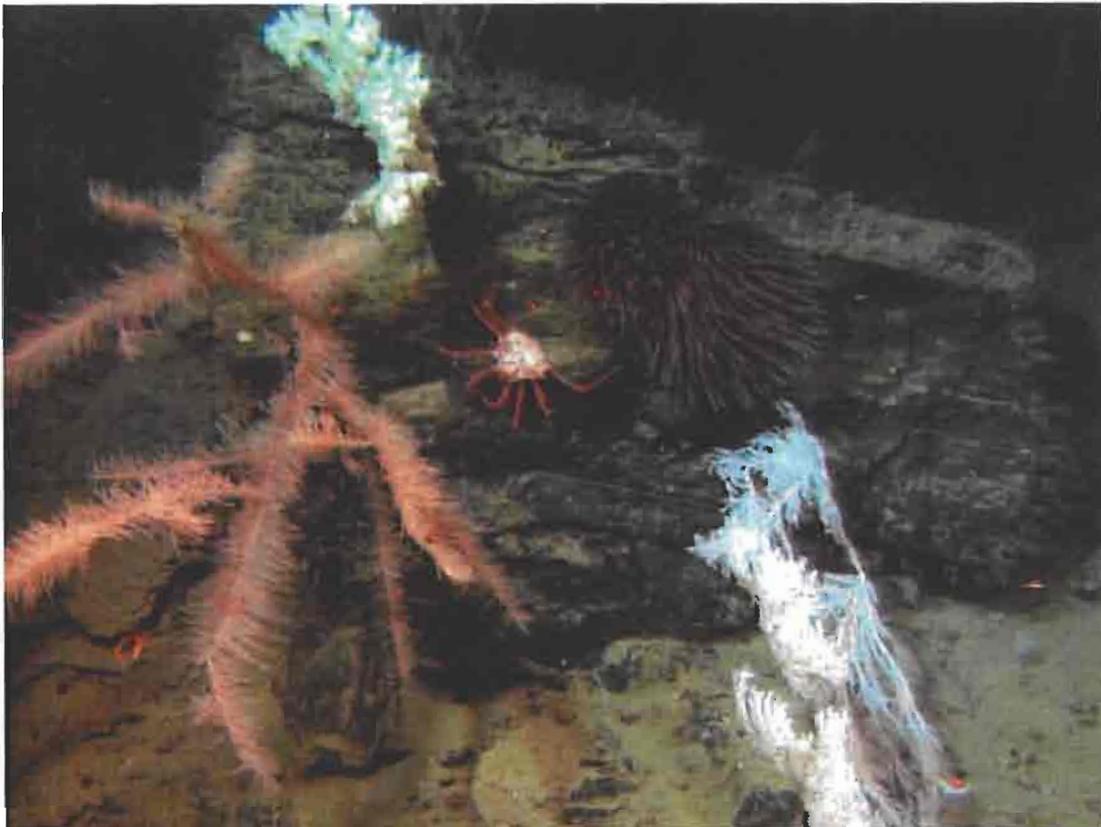


Appendix B

Preliminary Report on Occurrences of
Structure-Forming Megafaunal
Invertebrates
off the West Coasts of Washington,
Oregon and California



August 2004
Fishery Resource Analysis & Monitoring Division
Northwest Fisheries Science Center



Cover page: Video frame grab image taken at a depth of 1004 meters in Astoria Canyon off the mouth of the Columbia River with the ROPOS ROV's broadcast quality camera showing an antipatharian or black coral (pinkish orange branched structure on left), gorgonians (two white branched corals), a sea anemone, and crab (probably a "scarlet king crab" (*Lithodes cousei*))

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I. INTRODUCTION AND BACKGROUND

In comparison to their tropical counterparts, the knowledge on cold water/deep-sea corals is limited. Scientists still know little about their distribution, biology, and their function as essential fish and invertebrate habitat. Recently, interest has been building among the scientific community and the public to determine the role of these coral and other biogenic species in the ecosystem and their relation to commercial fisheries.

Cold water/deep-sea corals are found in temperate waters worldwide and at various depths from the continental shelf down to the abyssal plain. They consist of cnidarian families of octocorals (e.g., gorgonians like red tree corals and bamboo corals, and sea pens and whips), hexacorals (e.g., stony corals and black corals), and hydrocorals (e.g., lace corals). They are long-lived, and slow growing, and probably vulnerable to physical disturbance. In addition to corals, other structure-forming megafaunal invertebrates such as sponges and anemones are also a critical component of the habitat of continental shelf and slope ecosystems. Structure-forming megafaunal invertebrates refer to any epibenthic organism that grows to sufficient size to provide potential habitat structure for other benthic organisms and fishes.

If we are to appropriately manage and protect the ecosystems in which cold water/deep-sea corals and other structure-forming invertebrates reside, there is clearly a need to build an information base about these organisms. The ecosystem function of these species, especially as it relates to fish habitat needs to be defined. In addition, their habitat preferences and vulnerability to disturbance need to be determined. In order to do so, initially a quantitative description of their distribution and local environment must be completed. Other information such as the rate of dispersal, recolonization, and growth, as well as such things as their systematics, larval ecology and genetics must be collected.

As a first step in developing the requisite information base, we located, charted, and described the distribution of known collections of structure-forming megafaunal invertebrates. This initial mapping effort was produced to inform the EFH/EIS process and is a first step

in synthesizing the available information.

Unfortunately, targeted studies on these species are very limited. The existing data were primarily collected during surveys of fish populations and therefore only represent occurrences. In many cases the taxonomic information from these data are poor or are not available. Therefore there are limitations on the interpretation of the data.

There have been few high resolution mapping studies of these organisms on the west coast. However, these high-resolution studies have the best taxonomic and most precise location information. Thus, we have included information from two unpublished studies in this summary. Additional data from academic institutions and museums were compiled by Entnoyer and Morgan (2003) and those data are also included in this summary.

The objectives of this report are to:

1. Identify the occurrences of cold water/deep-sea corals and other biogenic species from all previous collections
2. Place these observations on the existing hydrographic and geological framework
3. Evaluate if obvious patterns in distribution are apparent.

We hope that this will form the beginning of a comprehensive information base on these important organisms.

II. METHODS

For this study, we gathered data on observations of structure-forming megafaunal invertebrates collected primarily within federal waters of the exclusive economic zone (EEZ) of the United States off the coasts of Washington, Oregon, and California. Two exceptions are: 1) Southern California Coastal Water Resource Project (SCCWRP); which includes bottom trawl observations within California state waters, and 2) Monterey Bay Aquarium Research Institute (MBARI) submersible/ROV observations; which include dives also within California state waters (i.e. Monterey Bay). Some studies include data collected outside the EEZ, but those are not included in this report.

Many of the data used represent aggregated catch from trawls towed over kilometers of seabed, and often times were collected during regional surveys. On the other hand, some high-resolution studies were conducted at specific sites off Oregon and California. These studies include observations interpreted from submersible video recordings of organisms in situ; and are represented either as point locations or observed densities along habitat patches that extend over meters and tens of meters of seabed. When possible, catch or observational data are normalized by trawl net swept area or submersible transect area, respectively.

Observations of megafaunal invertebrates from numerous sources were catalogued according to species codes listed in the RACE survey database (RACEBASE). RACEBASE does not include an exhaustive listing of all invertebrates but includes many of the structure-forming megafaunal species of concern for this study. These codes encompass species from nine orders (Actiniaria, Antipatharia, Corallimorpharia, Gorgonacea, Pennatulacea, Scleractinia, Filifera, Zoanthidea, and various pooled orders of Phylum Porifera) and twenty-eight families (Acanthogorgiidae, Actinernidae, Actinidae, Actinostolidae, Alcyonidae, Anthoptilidae, Antipathidae, Aphrocallistidae, Caryophyllidae, Corallimorphidae, Halichondridae, Haloclavidae, Hormathidae, Hyalonematidae, Isididae, Leuconidae, Liponematidae, Metrididae, Nephtheidae,

Paragorgiidae, Pennatulidae, Plexauridae, Primnoidae, Rossellidae, Suberitidae, Tethyidae, Umbellulidae, Virgularidae). For mapping purposes, some orders and families were not plotted because they were either unknown, not benthic, or too small. Due to the complex taxonomy of sponges, all orders of Phylum Porifera were pooled into one group. Structure-forming invertebrate species not included in RACEBASE but in other studies were appended and categorized taxonomically.

Data Sources

West Coast Groundfish Bottom Trawl Survey

In summer 1998, the West Coast Slope Groundfish Survey was begun by the NWFSC. Conducted annually, the geographic extent of the survey has evolved over the years. From 1998-2001, survey trawls were made from the Canadian border southward to Pt. Conception at depths ranging from 100 to 700 fathoms. In 2002, the survey was expanded southward to the Mexican border and in 2003 the shoreward depth boundary was expanded inshore to 30 fathoms. From 1998-2002, an east west transect design with 10° intervals was utilized; and in 2003 a grid design was implemented to provide stratified, random selection of 2.0x1.5 nmi grid cells. Prior to 2001, invertebrate identification was not a priority so this study focuses on observations recorded from 2001-2003. Catch records of structure-forming megafaunal invertebrates from 1,406 bottom trawls include 1,941 occurrences from seven orders (Actiniaria, Antipatharia, Corallimorpharia, Gorgonacea, Pennatulacea, Scleractinia, and various pooled orders of Phylum Porifera) and thirteen families (Actinernidae, Actinidae, Alcyonidae, Anthoptilidae, Antipathidae, Caryophyllidae, Hormathidae, Isididae, Liponematidae, Metrididae, Paragorgiidae, Plexauridae, Virgularidae). Ancillary data on depth and bottom temperature were also recorded.

West Coast Groundfish Observer Program (WCGOP)

WCGOP began in September 2001. The goal of the program is to monitor and record commercial bycatch data, including species composition of retained and discarded catch, and to collect critical biological data such as fish length, sex, and weight. The program observes vessels permitted for the limited-entry groundfish trawl and

fixed gear fisheries, as well as some vessels that are part of the open-access groundfish fleet. Primary animals of interest are marine mammals, endangered salmon species, and overfished groundfish species, however information on coral, anemones, and sponge bycatch is recorded. Detailed taxonomic classification of these species is very limited at this time.

Records from 12,411 observed hauls or sets from trips made between September 2001 and February 2004 were queried to identify catches of structure-forming invertebrates. Since specific identification of invertebrates for the most part was not included in observer collection protocols until recently, the data currently available were categorized into four general groups (corals, sea pens, sponges, and anemones). Furthermore, observers were not trained to evaluate the disposition (live vs. dead) of coral samples, so catches of corals do not necessarily represent areas of known live coral aggregations.

Heceta Bank Fisheries Investigations – Submersible and ROV observations

Heceta Bank, off the central Oregon coast is the site of ongoing investigations of demersal fish habitats by the NWFSC and collaborators. Major goals of these investigations are to utilize in situ survey technologies to enumerate demersal fishes and megafaunal invertebrates and characterize fish habitat. In 2000 and 2001, twenty-seven ROV and submersible dives were made at five of six stations used in historical studies and at thirteen new sites. In 2002, eighteen submersible dives were made at six historical stations. Submersible dives occurred at 68-342 meters water depth with a mean depth of 113 meters (Tissot et al., in prep.). Observations of megafaunal invertebrates were recorded via video and normalized by transect area.

Alaska Fisheries Science Center (AFSC) – Resource Assessment and Conservation Engineering Division (RACE) West Coast regional trawl surveys

A total of 10,218 survey trawls from research cruises off Washington, Oregon, and California occurred from 1977 through 2001. Catch records include 7,560 occurrences of structure-forming invertebrates,

including organisms from seven orders (Actiniaria, Antipatharia, Corallimorpharia, Gorgonacea, Pennatulacea, Scleractinia, and various pooled orders of Phylum Porifera) and twenty families (Acanthogorgiidae, Actinernidae, Actinidae, Actinostolidae, Alcyonidae, Anthoptilidae, Antipathidae, Caryophyllidae, Haloclavidae, Hormathidae, Isididae, Liponematidae, Metrididae, Nephtheidae, Paragorgiidae, Pennatulidae, Plexauridae, Primnoidae, Umbellulidae, Virgularidae).

*Southern California Coastal Water Resource Project (SCCWRP)
Survey bottom trawls*

During 1994 and 1998 SCCWRP conducted bottom trawls during surveys in the Southern California Bight (<http://www.sccwrp.org/>). During these years 915 trawl catches were sampled. Catch records from SCCWRP trawls include 48 observations of structure-forming megafaunal invertebrates from Orders Actiniaria, Pennatulacea, Scleractinia, Phylum Porifera and Families Caryophyllidae, Metrididae, Pennatulidae.

Occurrences of Habitat-forming Deep Sea Corals in the Northeast Pacific Ocean – A Report to NOAA’s Office of Habitat Conservation- Peter Etnoyer and Lance Morgan, Marine Conservation Biology Institute

Much of the cold and deep-sea coral records on the West Coast were summarized by Etnoyer and Morgan (2003). A total of ten institutions provided geo-referenced data to authors on the distribution of deep-sea corals. These institutions included:

- California Academy of Sciences (CAS)
- Canadian Museum of Nature and Department of Fisheries and Oceans (CMN-DFO)
- Monterey Bay Aquarium Research Institute (MBARI)
- National Museum of Natural History at the Smithsonian Institution (NMNH)
- National Oceanic and Atmospheric Administration (NOAA) – Office of Ocean Exploration (NOAA-OE)
- National Marine Fisheries Service – RACEBASE (RACE)
- Santa Barbara Museum of Natural History (SBMNH)
- REEF Foundation (REEF)

- Scripps Institution of Oceanography (SIO)
- A study performed by the late Dr. Robert Cimberg for VTN Oregon (Cimberg).

These data were categorized into eight coral families, including: Antipathidae, Oculinidae, Caryophylliidae, Corallidae, Isididae, Paragorgiidae, Primnoidae and Stylasteridae

Common attributes of all data points were latitude, longitude, family, species name, and depth in meters. Data were also ranked by two factors: 1) whether a physical sample is associated with the record and 2) the identifiers level of expertise.

Unpublished data; M. Yoklavich, Southwest Fisheries Science Center and M. Love, University of California at Santa Barbara

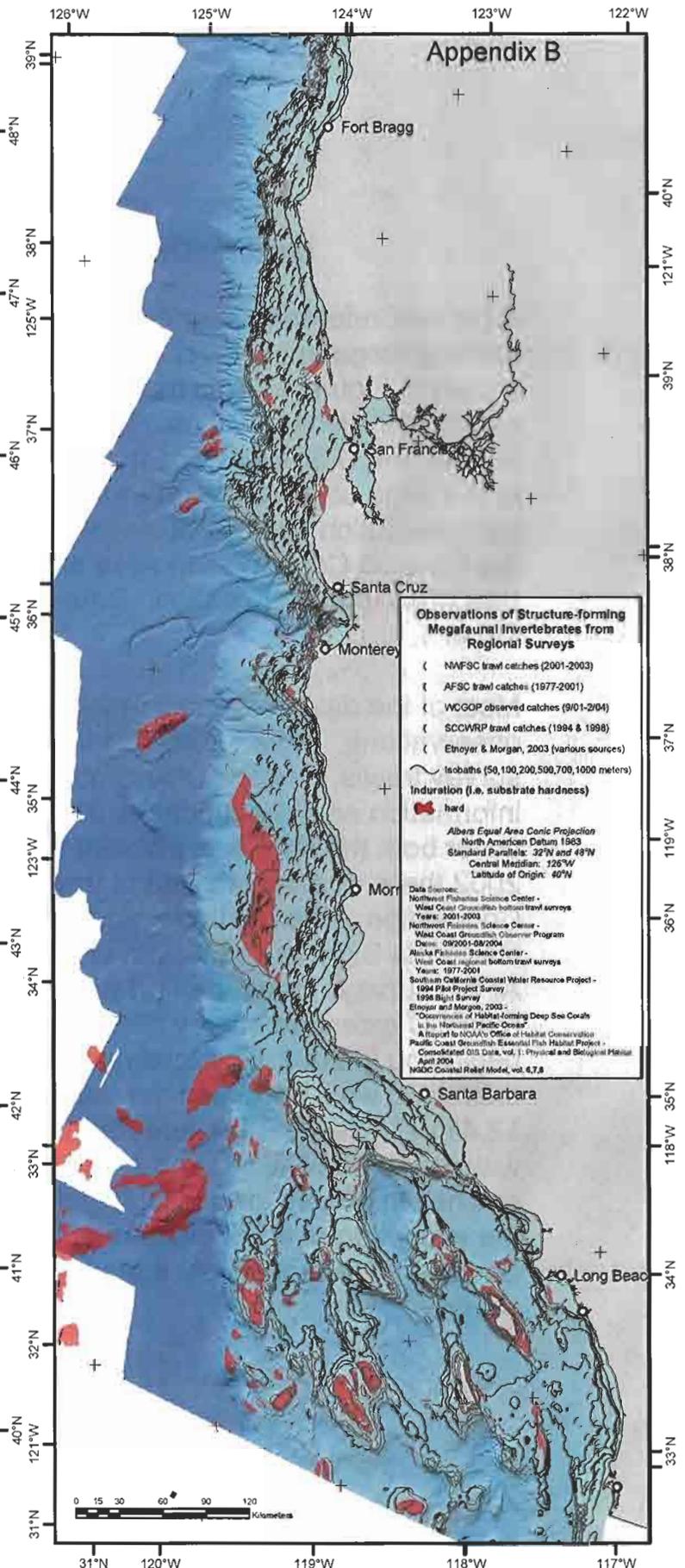
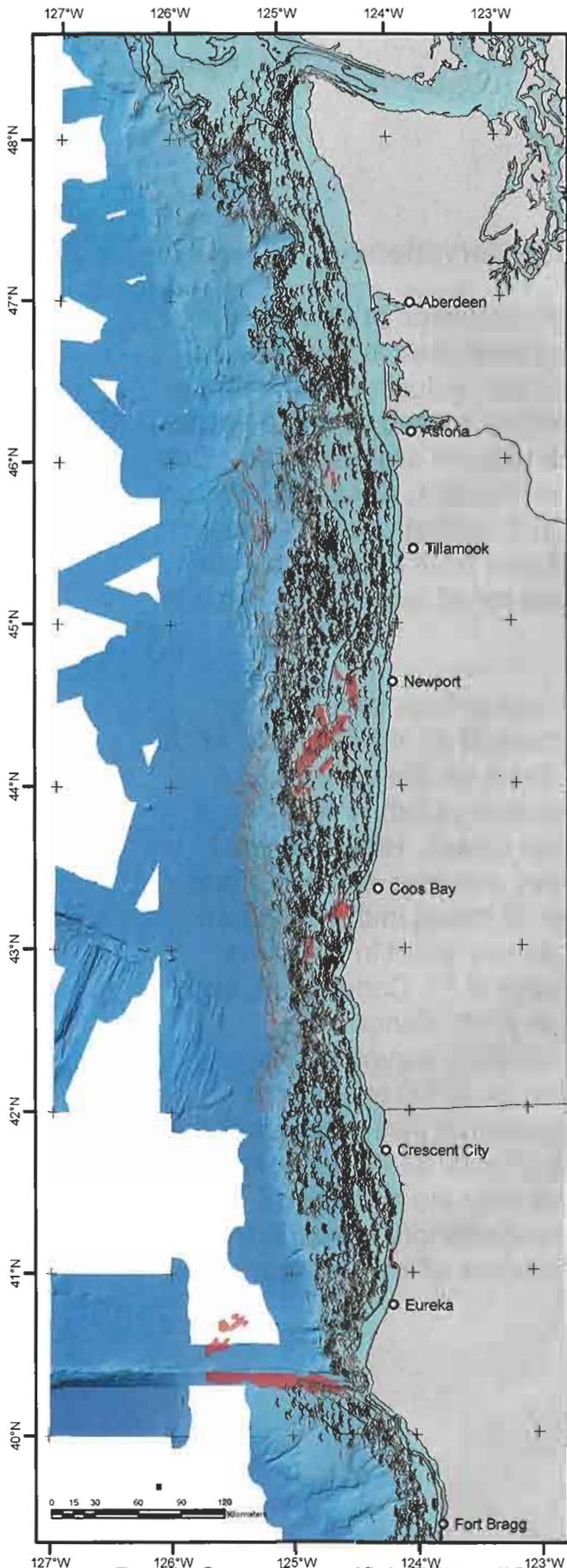
Yoklavich and Love (unpublished) have conducted submersible dives in the Cowcod conservation area in 2003. Included in this report are their observations of occurrences of black corals (Order Antipatharia) in that area. For more information regarding their research, please contact Mary Yoklavich at the Southwest Fisheries Science Center.

III. RESULTS

General Distribution of Observations

A general reference map depicting the occurrences of all structure-forming megafaunal invertebrate observations used in this study is shown in Figure 1. This map gives a general indication of the spatial extent of the observations. The observations extend over the entire EEZ off the U.S. West Coast and 13,939 records are displayed. Due to the large scale of the reference map in Figure 1, observations from high-resolution surveys at Heceta Bank (off central Oregon) and in the Cowcod Conservation Area are excluded from Figure 1 but are described in a later section. Data sources for all records are listed in Table 1.

Most of the data presented in this report come from trawl survey observations. Figure 2 depicts the locations of all NWFSC and AFSC survey trawls. These surveys primarily focus on the collection of information on the abundance and distribution of fish. The surveys cover both the shelf and slope of the West Coast. However, until 2002 there was very limited of trawl survey activities south of Point Conception. The relatively small number of trawls in the Southern California Bight is a reflection of limited survey effort in that area. AFSC surveys focused effort primarily north of Pt. Conception; and NWFSC extended survey coverage south of Pt. Conception beginning in 2002. The total number of NWFSC survey trawls examined was 1,406 and the total number of AFSC trawls was 12,411 (Table 1). Structure-forming megafaunal invertebrates occur widely in both NWFSC and AFSC trawls (Figure 3). The invertebrate catches in survey tows is fairly ubiquitous over the entire EEZ, with the exception of a few clusters of tows near offshore banks in the Southern California Bight that show no records of invertebrate catches.



Appendix B

Observations of Structure-forming Megafaunal Invertebrates from Regional Surveys

- (NAFSC trawl catches (2001-2003)
- (AFSC trawl catches (1977-2001)
- (WCGOP observed catches (9/01-2/04)
- (SCCWRP trawl catches (1984 & 1998)
- (Etnoyer & Morgan, 2003 (various sources)

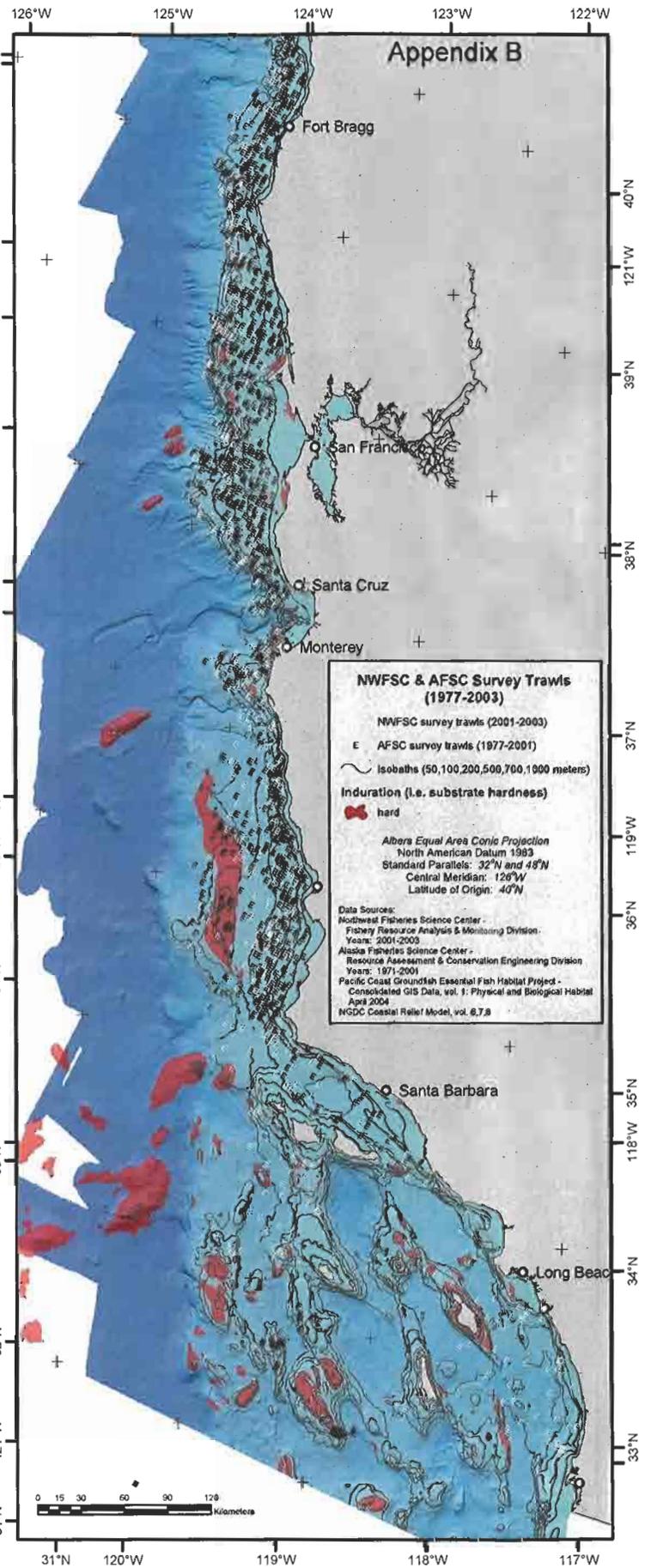
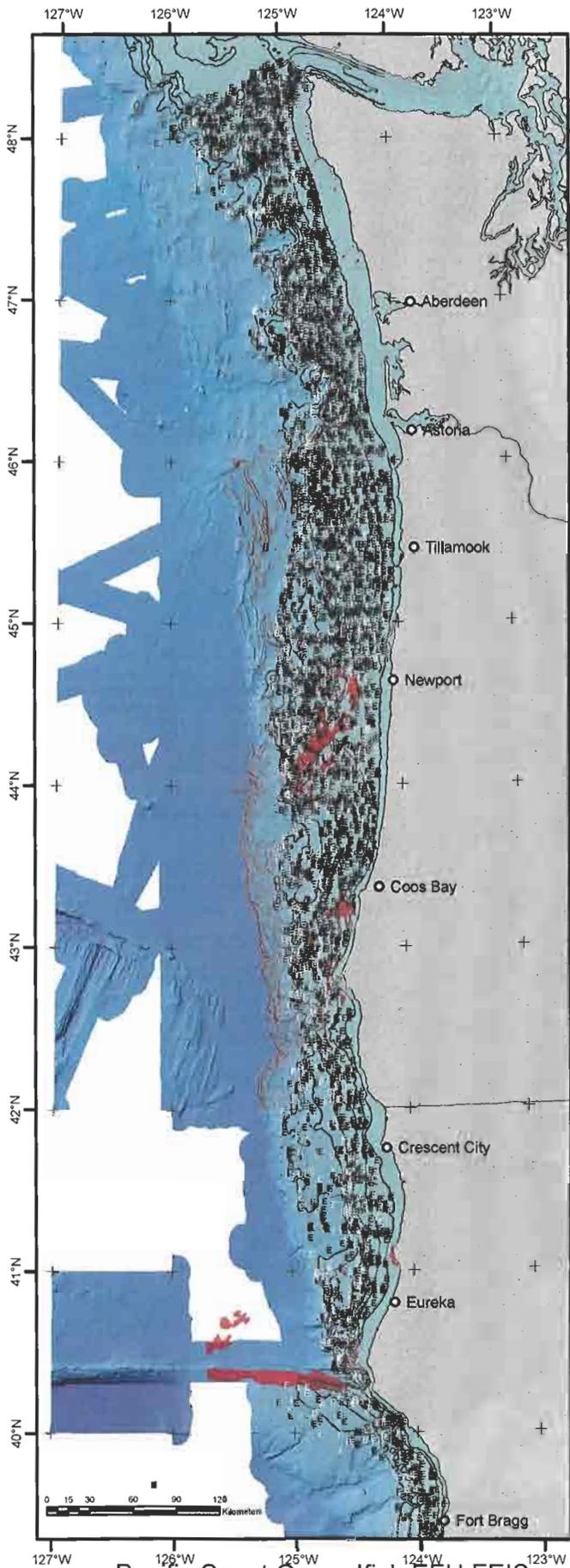
Isobaths (50, 100, 200, 500, 700, 1000 meters)

Induration (i.e. substrate hardness)

- hard

Albers Equal Area Conic Projection
 North American Datum 1983
 Standard Parallels: 32°N and 49°N
 Central Meridian: 126°W
 Latitude of Origin: 40°N

Data Sources:
 Northwest Fisheries Science Center -
 West Coast Groundfish bottom trawl surveys
 Years: 2001-2003
 Northwest Fisheries Science Center -
 West Coast Groundfish Observer Program
 Dates: 09/01-02/04
 Alaska Fisheries Science Center -
 West Coast regional bottom trawl surveys
 Years: 1977-2001
 Southern California Coastal Water Resource Project -
 1994 Pilot Project Survey
 1998 Bight Survey
 Etnoyer and Morgan, 2003 -
 "Observations of Habitat-forming Deep Sea Corals
 in the Northeast Pacific Ocean"
 A Report to NOAA's Office of Habitat Conservation
 Pacific Coast Groundfish Essential Fish Habitat Project -
 Consolidated GIS Data, vol. 1: Physical and Biological Habitat
 April 2004
 NSDC Coastal Relief Model, vol. 6.7.8



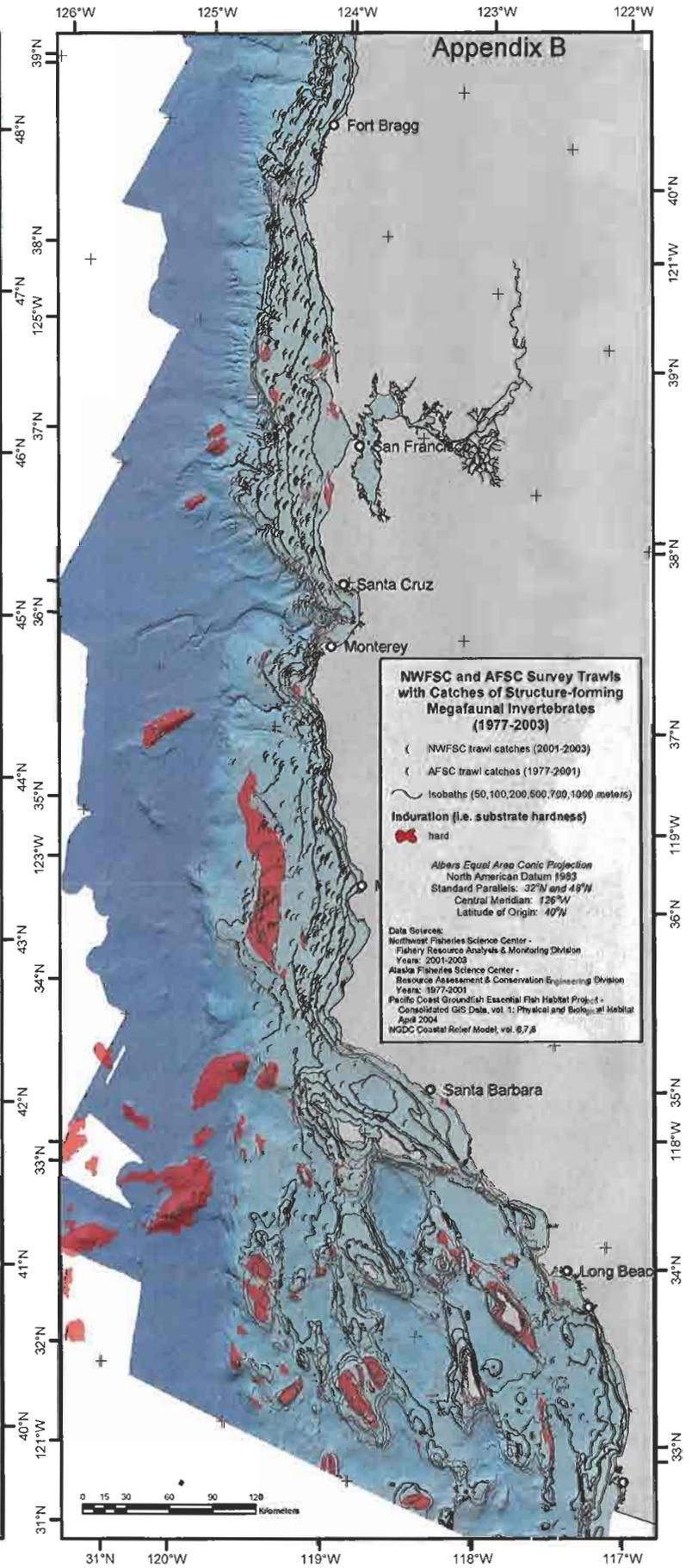
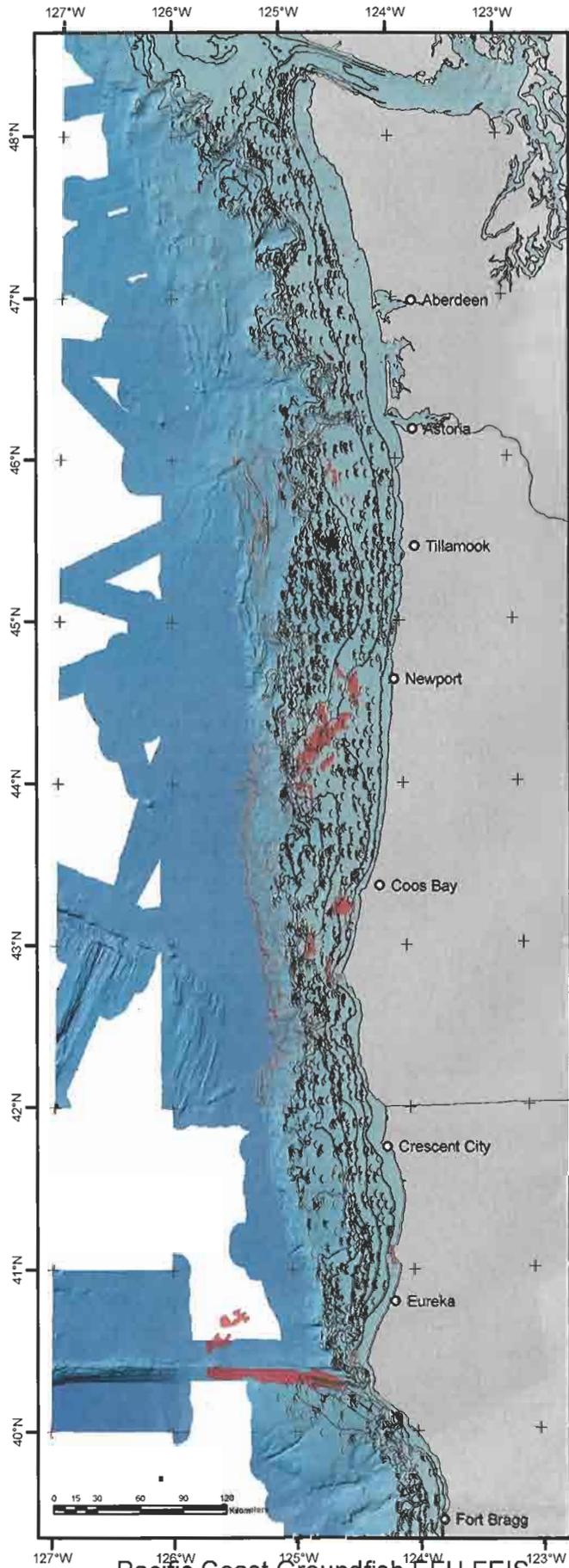


Table 1. Summary of Medium Scale Mapping Data sources

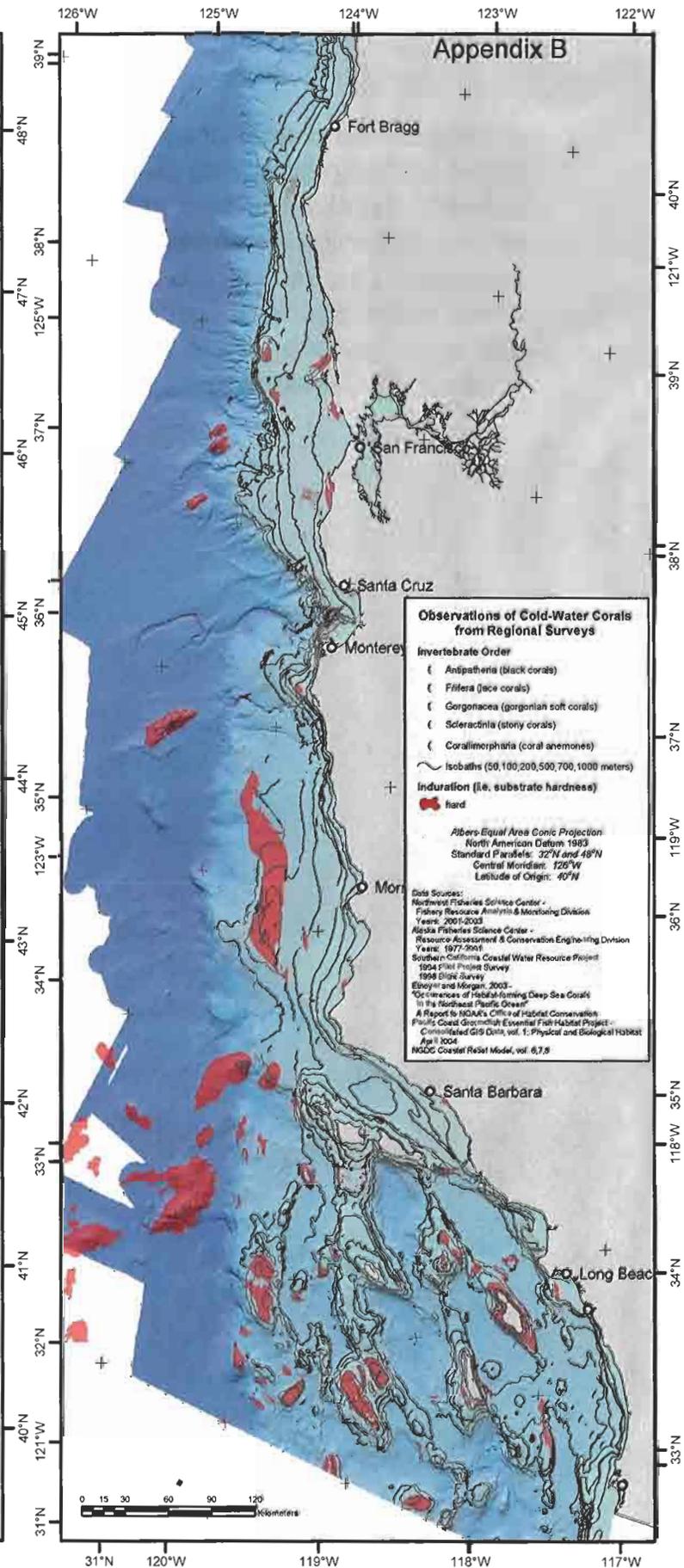
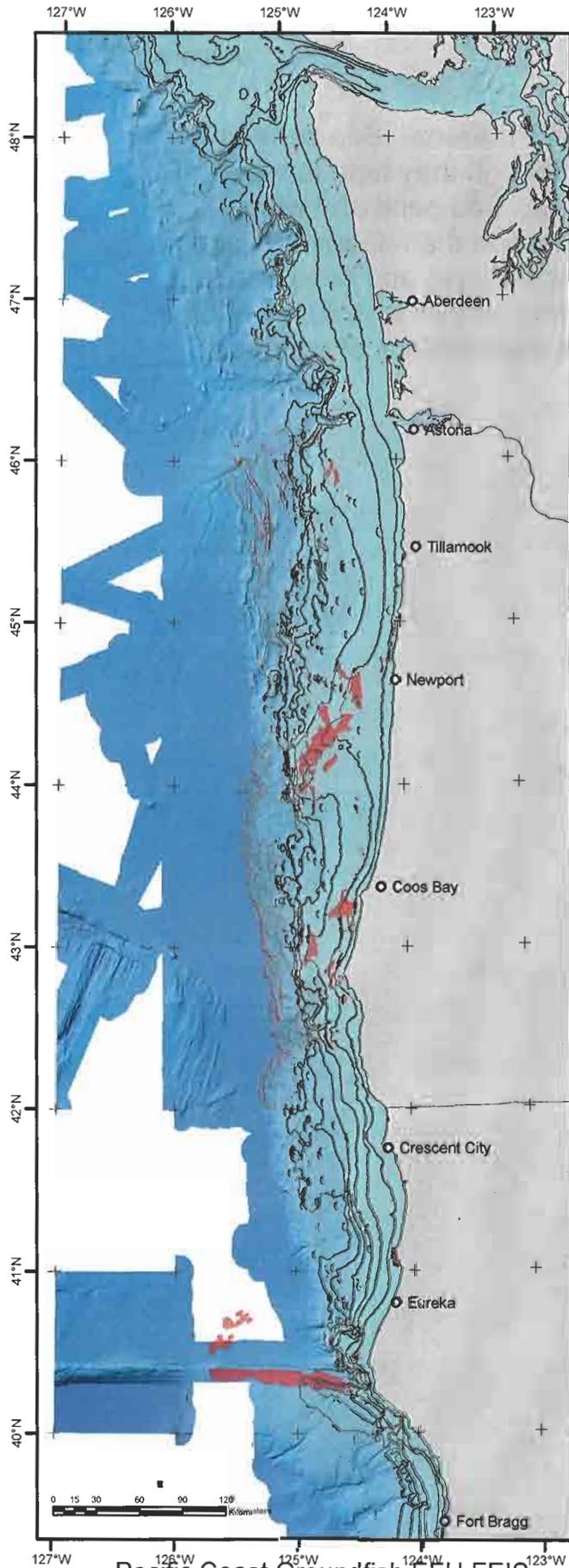
SOURCE	TYPE	TOTAL RECORDS REVIEWED	CORALS (BLACK AND STONY) (GORGONIANS) (CORAL ANEMOMES) (LACE CORALS)	SEA PENS AND WHIPS	SPONGES	ANEMOMES
NWFSC-FRAM: Division	West Coast Groundfish Slope Trawl Survey – 2001-2002	832	64 (20) (44) (0) (0)	114	150	737
NWFSC-FRAM: Division	West Coast Groundfish Combined Shelf/Slope Trawl Survey – 2003	574	65 (35) (29) (1) (0)	84	182	544
NWFSC-FRAM: Division	West Coast Groundfish Observer Program (WCGOP) – Sept. 2001-Feb 2004	12411	239 (NA) (NA) (NA) (0)	80	145	3548
AFSC RACE: Division	All West Coast regional trawl surveys – 1977-2001	10218	340 (125) (184) (31) (0)	1361	962	4897
Southern California Coastal Water Resource Project	1994 Pilot Project Survey bottom trawls	261	1 (1) (0) (0) (0)	7	1	13
Southern California Coastal Water Resource Project	Bight '98 Survey bottom trawls	654	6 (3) (3) (0) (0)	14	3	0
Etmoyer, P. and L. Morgan – Marine Conservation Biology Institute	Occurrences of Habitat-forming Deep Sea Corals in the Northeast Pacific Ocean – A Report to NOAA's Office of Habitat Conservation (all information excluding AFSC trawl surveys)	NA	381 (38) (315) (0) (28)	NA	NA	NA

Distributions of Structure-forming Megafaunal Invertebrates Organized by Order

Observations of cold water/deep sea corals from five invertebrate orders are portrayed in Figure 4. They include black corals (Order Antipatharia), lace corals (Order Filifera), gorgonian soft corals (Order Gorgonacea), stony corals (Order Scleractinia), and coral anemones (Order Corallimorpharia). Antipatharian observations appear concentrated north of Cape Mendocino with a few exceptions near Monterey Canyon, on Davidson Seamount (area of hard induration west-southwest of Monterey), and in the Southern California Bight. Gorgonians range from Cape Flattery, Washington southward into the Southern California Bight, but their distribution is fairly patchy south of Monterey, California. North of Monterey, gorgonians appear concentrated on the continental slope. Six gorgonian observations also occur on or near a large patch of hard induration (close to Santa Lucia Escarpment) off Morro Bay, California. Filiferan, Scleractinian, and Corallimorpharian observations were fairly scarce throughout the EEZ; and discerning any spatial patterns proved problematic due to their low sample numbers.

Etnoyer and Morgan (2003) compiled records from AFSC surveys and as well as from other institutions. Information from the AFSC surveys is included in Figure 4. The additional observations of black corals (Order Antipatharia), lace corals (Order Filifera), gorgonian soft corals (Order Gorgonacea), and stony corals (Order Scleractinia) summarized by these authors are presented in Figure 5. Again, Antipatharian observations appear concentrated north of Cape Mendocino and on the continental slope. The low sample numbers of Filiferan, Gorgonian, and Scleractinian observations off the West Coast preclude any determination of geographic distributions.

Figure 6 depicts the observations of other structure-forming megafaunal invertebrates from NWFSC, AFSC, and SCCWRP research trawls. Catch records are organized into three categories, including sea anemones (Order Actiniaria), sea pens and sea whips (Order Pennatulacea), and various pooled orders of sponges (Phylum Porifera). The distribution of anemones appears fairly ubiquitous throughout the survey area. Sponge observations are conspicuously absent between Cape Mendocino and Santa Cruz, California with the



Observations of Cold-Water Corals from Regional Surveys

Invertebrate Order

- (Antipatharia (black corals)
- (Filicera (lace corals)
- (Gorgonacea (gorgonian soft corals)
- (Scleractinia (stony corals)
- (Corallimorpharia (coral anemones)

Isobaths (50, 100, 200, 500, 700, 1000 meters)

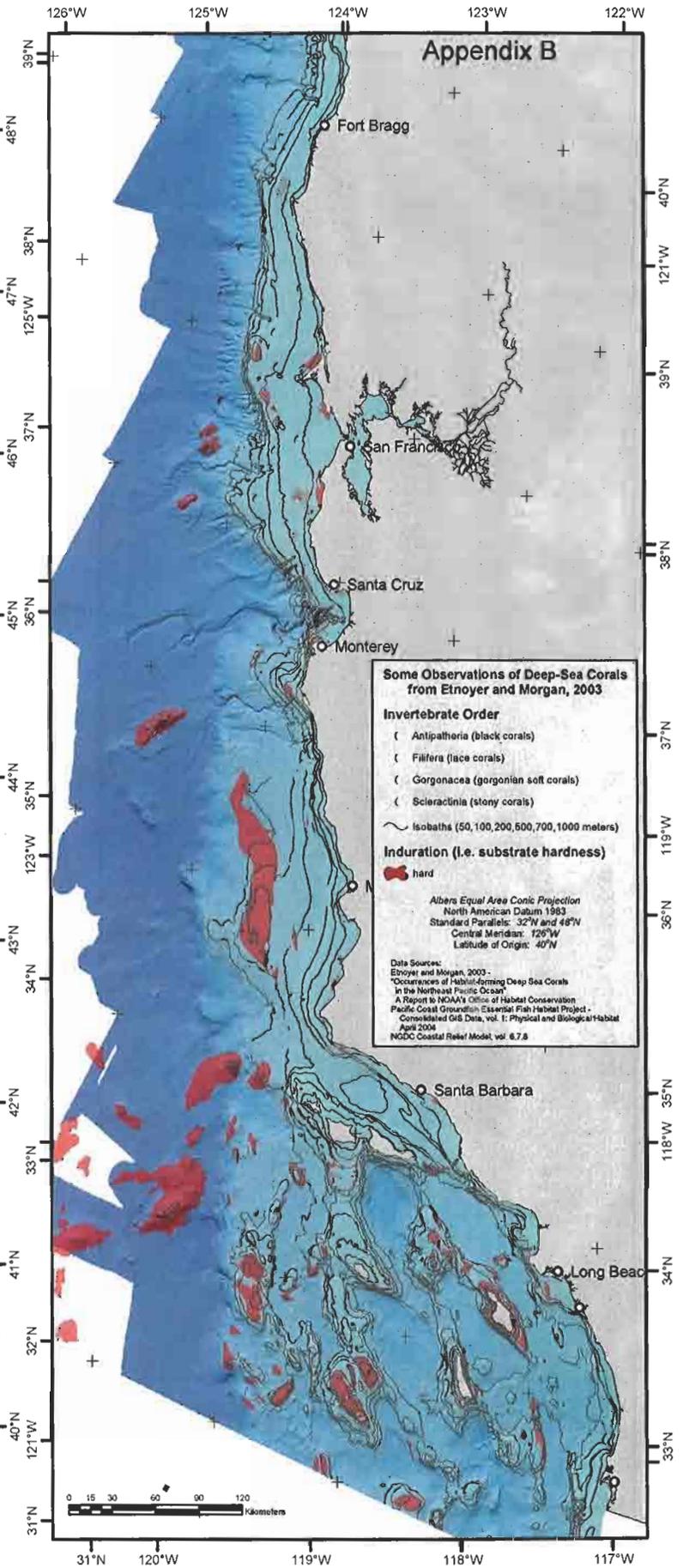
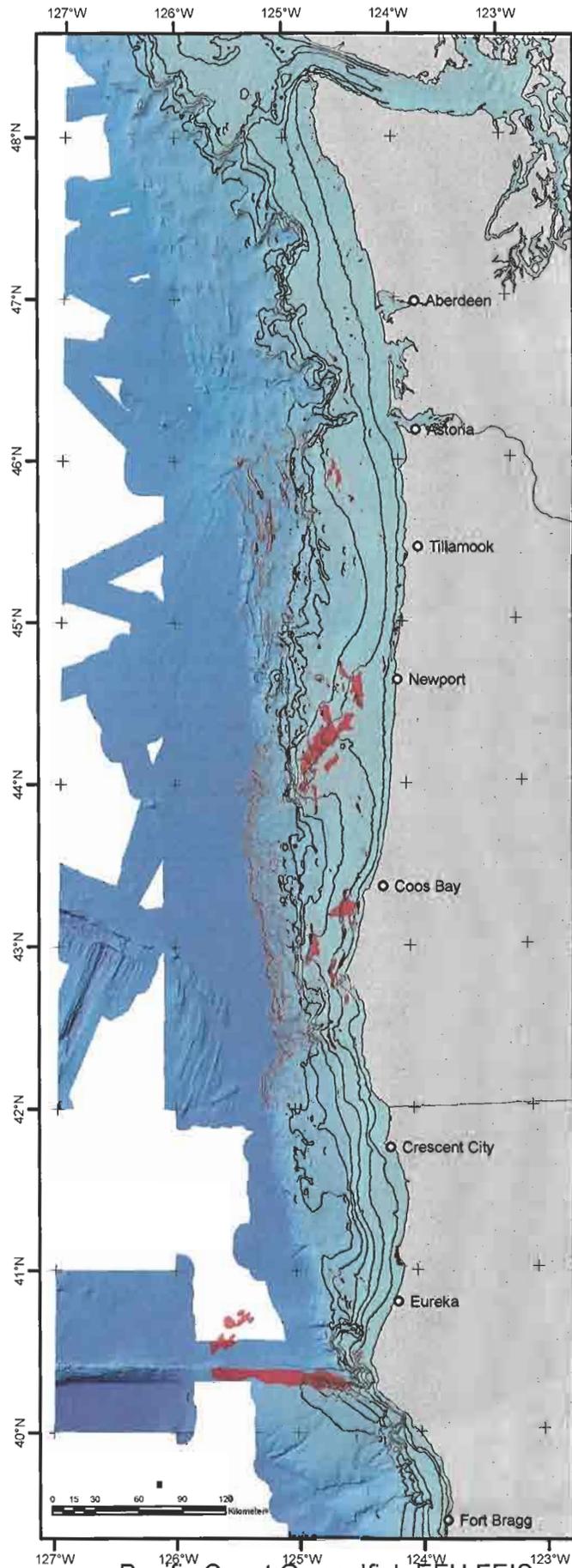
Induration (i.e. substrate hardness)

Hard

Abers-Equal Area Conic Projection
 North American Datum 1983
 Standard Parallels: 32°N and 48°N
 Central Meridian: 125°W
 Latitude of Origin: 40°N

Data Sources:
 Northwest Fisheries Science Center -
 Fishery Resource Analysis & Monitoring Division
 Years: 2001-2003
 Alaska Fisheries Science Center -
 Resource Assessment & Conservation Engineering Division
 Years: 1977-2001
 Southern California Coastal Water Resource Project -
 1994 Pilot Project Survey
 1998 Dredge Survey
 Enoyer and Morgan, 2003
 "Occurrences of Habitat-forming Deep Sea Corals
 in the Northeast Pacific Ocean"
 A Report to NOAA's Office of Habitat Conservation
 Pacific Coast Groundfish Essential Fish Habitat Project
 Coralline GIS Data, vol. 1: Physical and Biological Habitat
 Apr. 2004
 NOAA Coastal Relief Model, vol. 6.7.8

exception of a cluster of observations off Pt. Arena. Sea pens and whips also exhibit a wide distribution, although they tend to taper off between Eureka and Monterey, California. Sea pens and whips appear to exhibit a narrower depth distribution than anemones and sponges. The low sample numbers of anemones and sea pens and whips in the Southern California Bight may be due to reduced effort in that area; however, there are numerous observations of sponges south of Pt. Conception.



Appendix B

Some Observations of Deep-Sea Corals from Etnoyer and Morgan, 2003

Invertebrate Order

- (Antipatharia (black corals)
- (Filifera (lace corals)
- (Gorgonacea (gorgonian soft corals)
- (Scleractinia (stony corals)

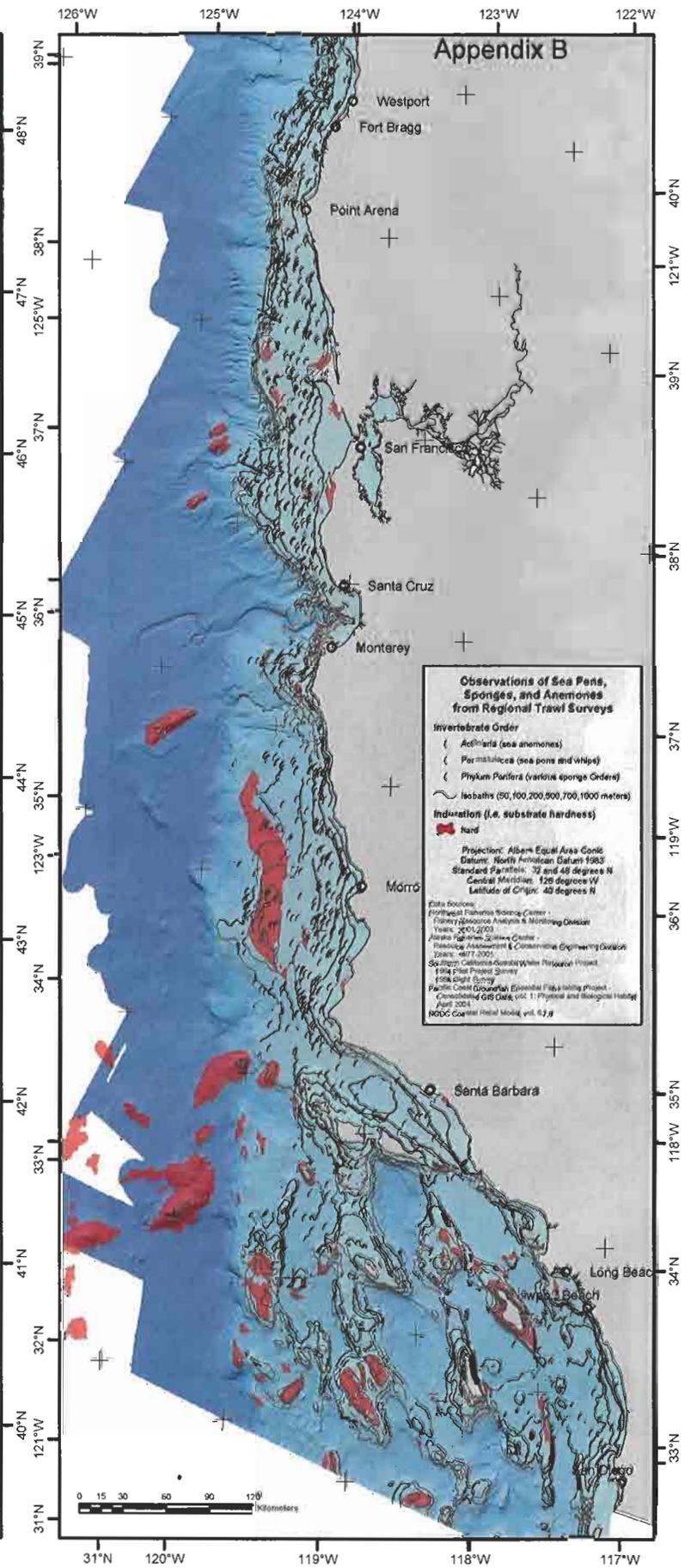
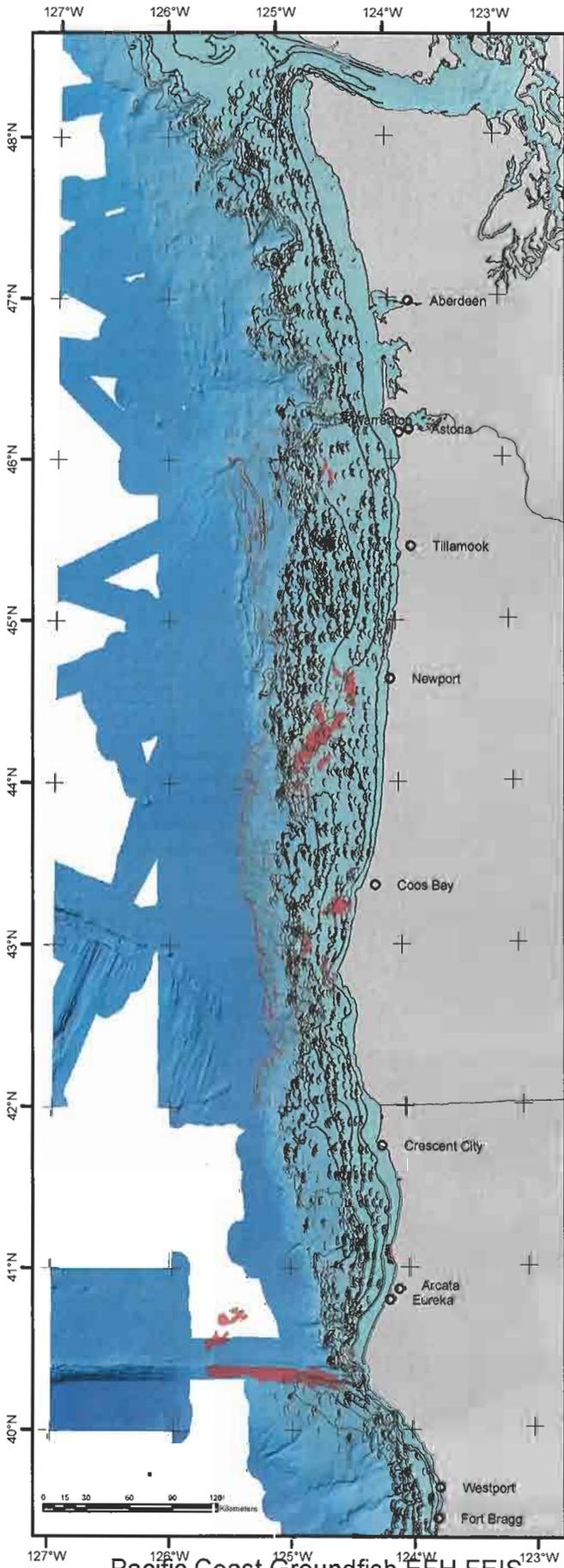
Isobaths (50, 100, 200, 500, 700, 1000 meters)

Induration (i.e. substrate hardness)

- hard

Albers Equal Area Conic Projection
 North American Datum 1983
 Standard Parallels: 32°N and 46°N
 Central Meridian: 126°W
 Latitude of Origin: 40°N

Data Sources:
 Etnoyer and Morgan, 2003 -
 "Occurrences of Habitat-Forming Deep Sea Corals
 in the Northeast Pacific Ocean"
 A Report to NOAA's Office of Habitat Conservation
 Pacific Coast Groundfish Essential Fish Habitat Project -
 Consolidated GIS Data, vol. 1: Physical and Biological Habitat
 April 2006
 NGDC Coastal Relief Model, vol. 6.7.8



Distributions of Structure-forming Megafaunal Invertebrates Organized by Family

Observations of seven families of sea anemones (Order Actiniaria) from NWFSC and AFSC survey trawls are shown in Figure 7. They include:

- Actinostolidae
- Actinernidae
- Actinidae
- Haloclavidae
- Hormathidae
- Liponematidae
- Metrididae

Metrididae (n=564) observations appear concentrated at shallower water depths, while Actinostolidae (n=1337), Hormathidae (n=400), and Liponematidae (n=764) observations are more prevalent at deeper water depths. The number of records of Actinernidae (n=19), Actinidae (n=21), and Haloclavidae (n=2) are too small to discern any meaningful spatial patterns. Additional observations of sea anemones are included in Figures 4 and 5, but not all samples were identified to the family level.

Figure 8 portrays the observations of one family (Antipathidae) of black corals (Order Antipatharia) from NWFSC and AFSC survey trawls and Etnoyer and Morgan, 2003. The distribution of Antipathidae (n=197) observations falls off markedly south of Cape Mendocino, with numerous catches concentrated off Oregon. Thirty-five samples described by Etnoyer and Morgan, 2003 occur in Monterey Bay and on Davidson Seamount (west-southwest of Monterey, California). Additional observations of black corals are included in Figures 4 and 5, but not all samples were identified to the family level.

Figure 9 portrays the observations of seven families of gorgonians (Order Gorgonacea) from NWFSC and AFSC survey trawls. They are:

- Acanthogorgiidae
- Alcyonidae

- Isididae
- Neptheidae
- Paragorgiidae
- Plexauridae
- Primnoidae

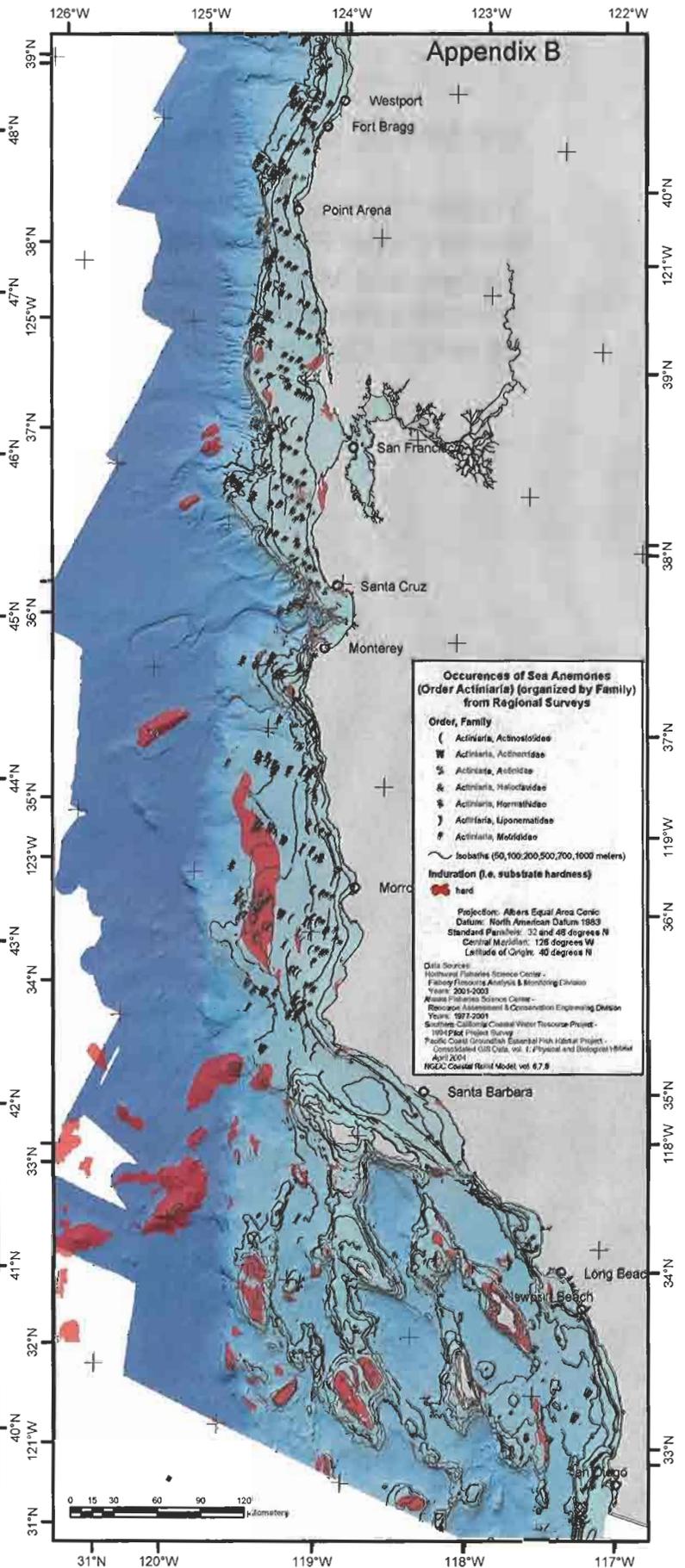
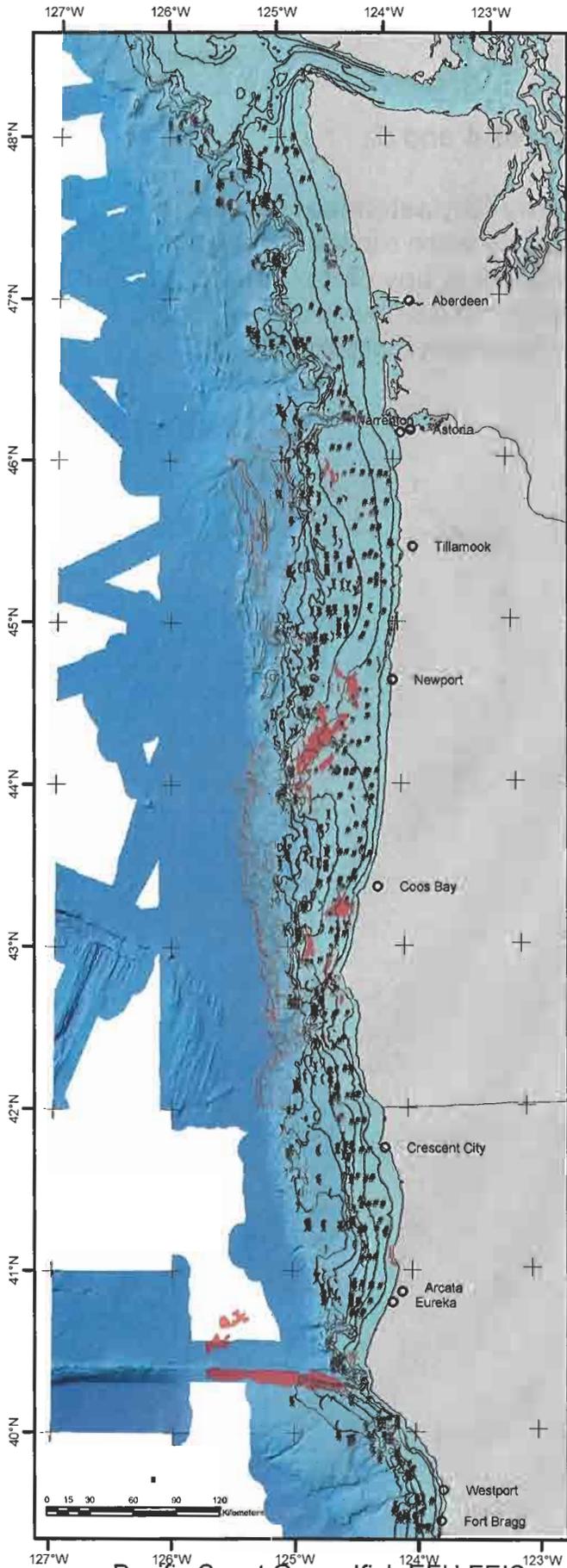
Gorgonian observations in general appear concentrated on the continental slope. Alcyonidae (n=72) and Plexauridae (n=42) observations dominate survey catch records of gorgonians. Etnoyer and Morgan, 2003 included 240 sample records of Family Isididae that were observed in Monterey Bay. All but five sample records of Family Paragorgiidae (n=68) were also included in Etnoyer and Morgan, 2003. All but one sample was collected in Monterey Bay. The number of records of Acanthogorgiidae (n=5), Neptheidae (n=2), and Primnoidae (n=16) are too small to discern any meaningful spatial patterns. Additional observations of gorgonians are included in Figures 4 and 5, but not all samples were identified to the family level.

Figure 10 shows the observations of four families of sea pens (Order Pennatulacea) from NWFSC, AFSC, and SCCWRP survey trawls. Virgularidae (n=572) are ubiquitous throughout the survey area. Sea pens in families Anthoptilidae (n=172) and Umbellulidae (n=122) are prevalent at deeper water depths with the Umbellulidae most prevalent north of Eureka, California. Numbers of records of Pennatulidae (n=48) are too small to discern any meaningful spatial patterns. Additional observations of sea pens are included in Figures 4 and 5, but not all samples were identified to the family level.

Figure 11 portrays observations of two families (Caryophyllidae and Oculinidae) of stony corals (Order Scleractinia) from NWFSC, AFSC, and SCCWRP survey trawls. Stony corals were caught only 18 times in NWFSC and AFSC survey trawls and only one of those eighteen samples was identified to family. Stony corals in Family Caryophyllidae were caught only four times in SCCWRP research trawls. Two observations in Family Caryophyllidae and one in Family Oculinidae from Etnoyer and Morgan (2003) are shown. Due to the low sample numbers we cannot identify any meaningful spatial patterns. Seventeen additional records of stony corals from NWFSC

and SWFSC surveys are included in Figures 4 and 5.

Figure 12 shows observations of one family (Stylasteridae) of lace corals (Order Filifera). Records of this family were reported only in Etnoyer and Morgan (2003) and did not occur in any of the other data sources summarized in this report. Most of the 28 observations occur off central California with a few from the Southern California Bight.



Appendix B

Occurrences of Sea Anemones (Order Actiniaria) (organized by Family) from Regional Surveys

Order, Family

- (Actiniaria, Actinostolidae
- W Actiniaria, Actinonidae
- & Actiniaria, Actinidae
- & Actiniaria, Halocladidae
- ⌋ Actiniaria, Normaniidae
-) Actiniaria, Liponematidae
- # Actiniaria, Metrididae

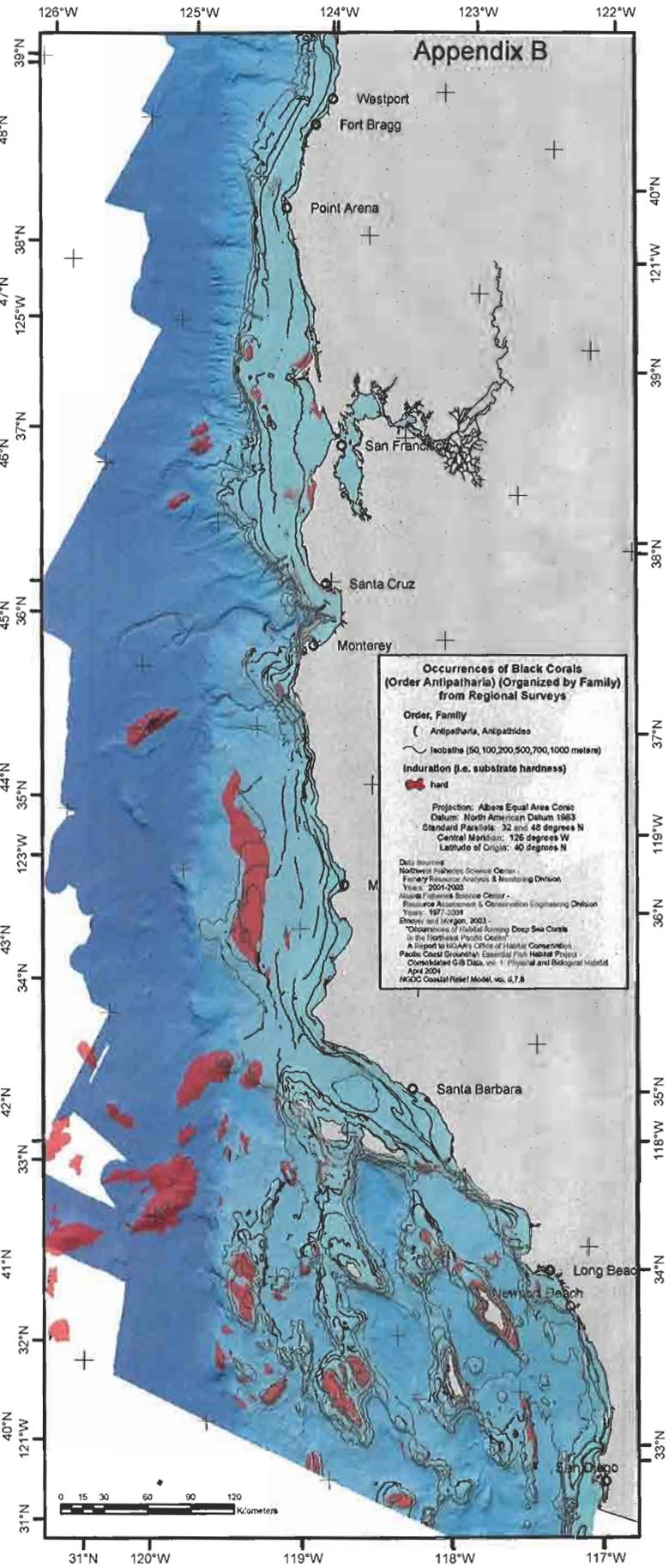
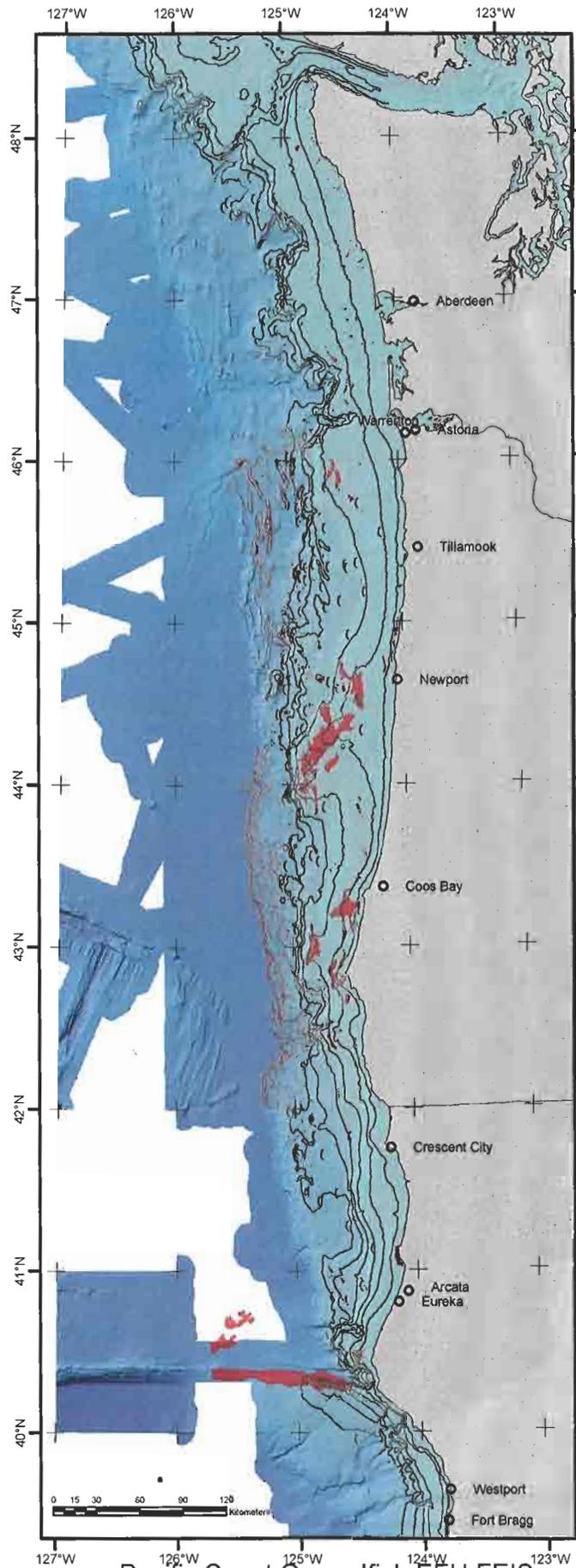
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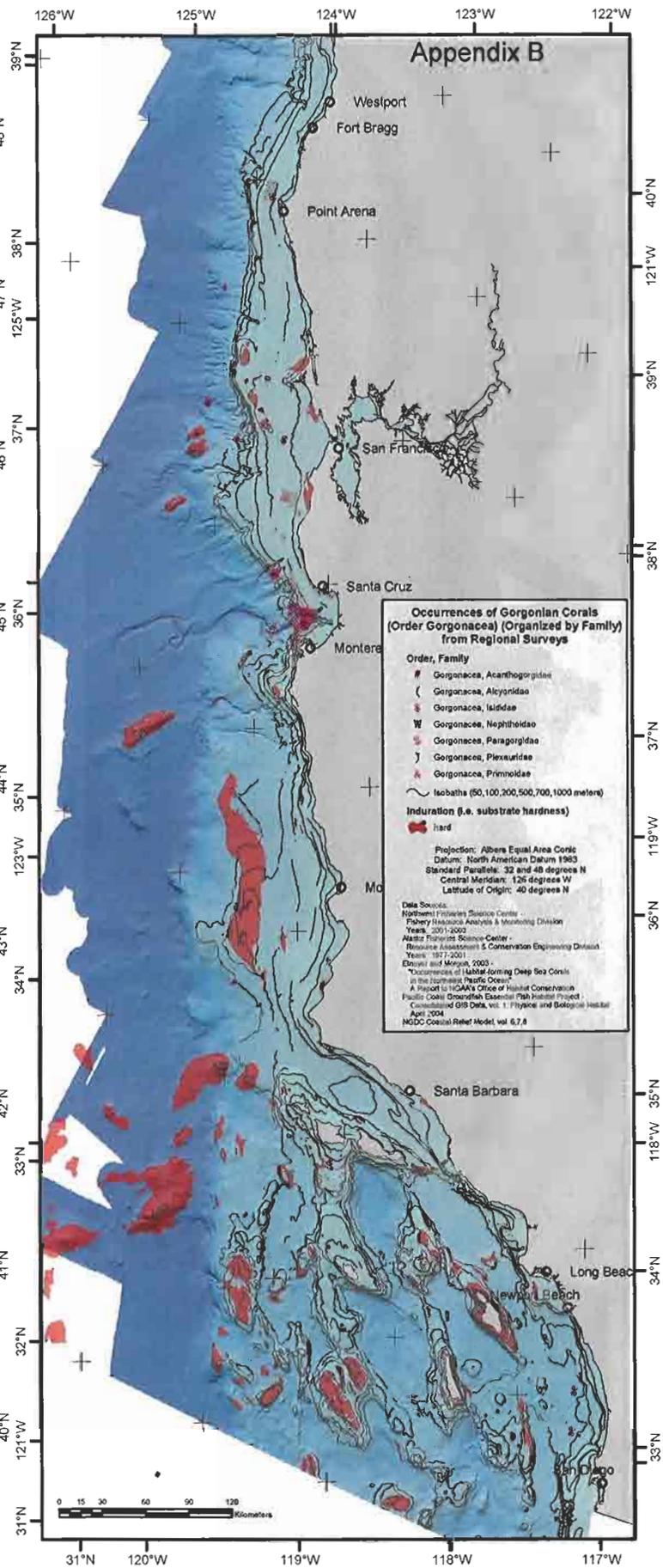
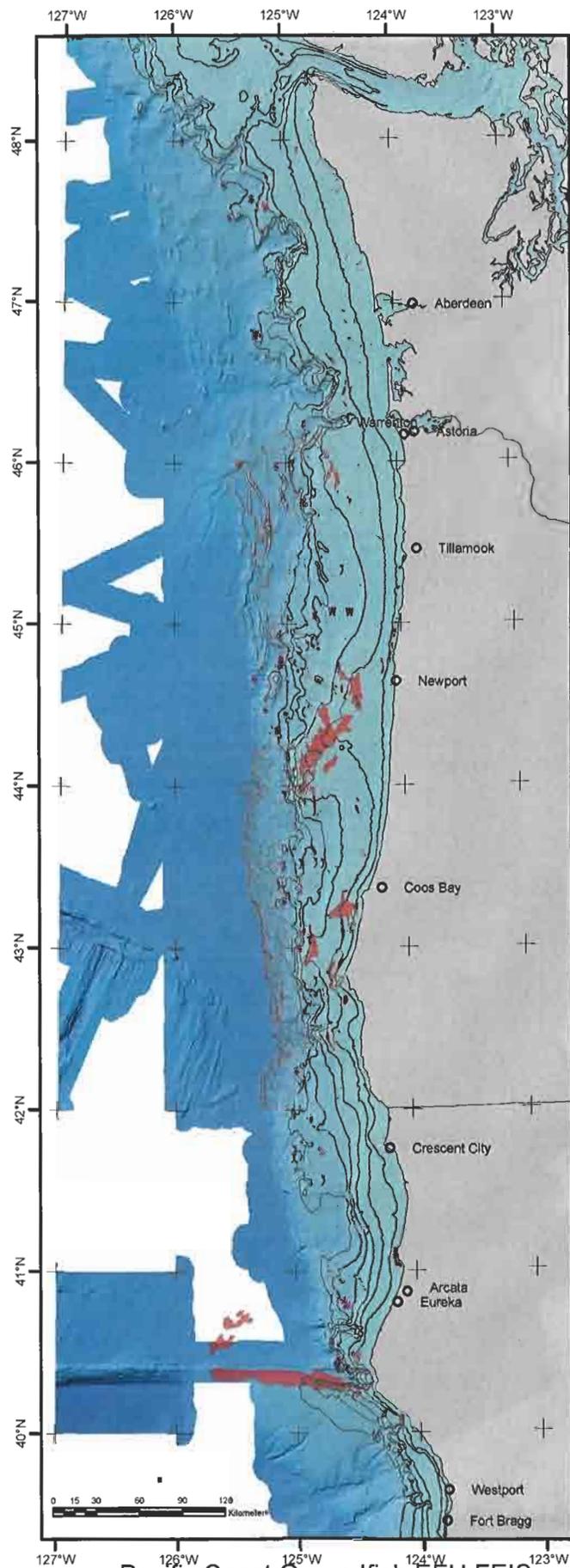
Induration (i.e. substrate hardness)

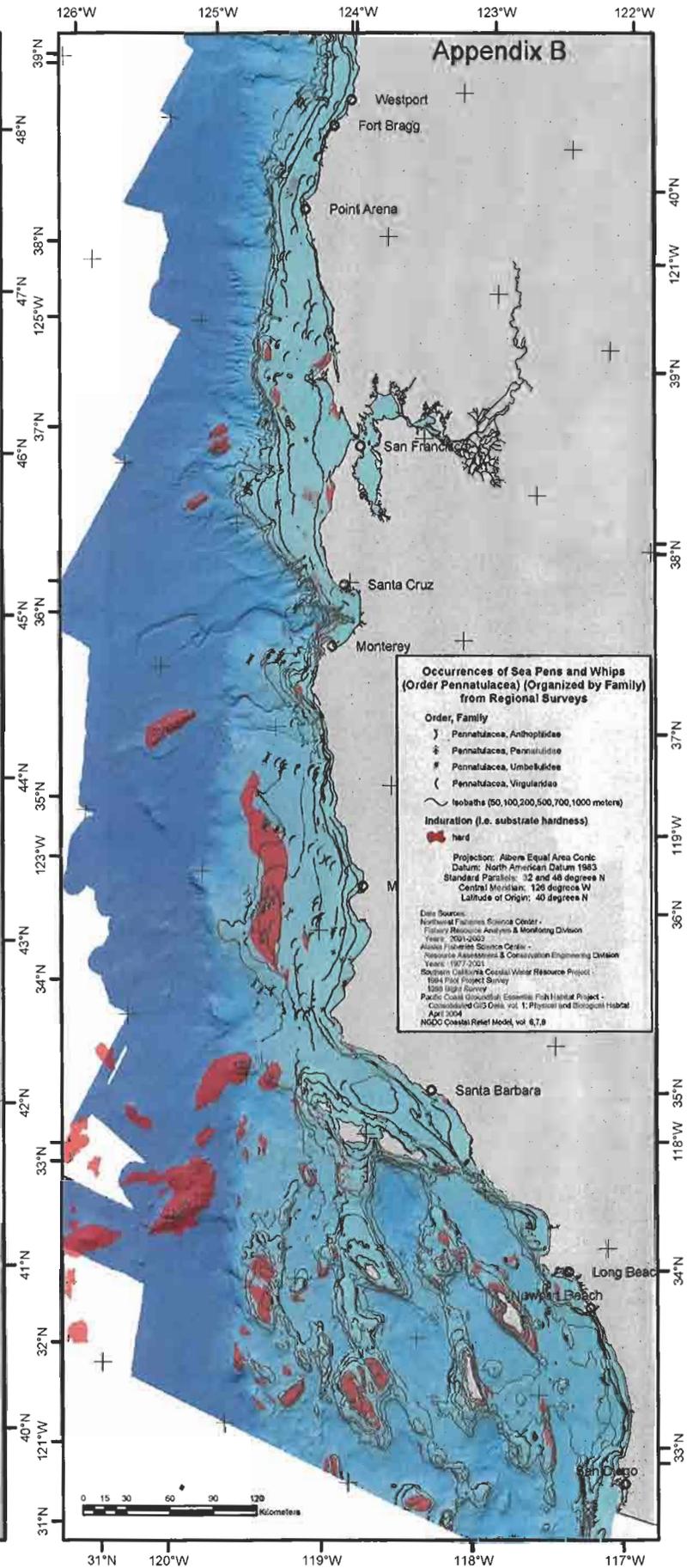
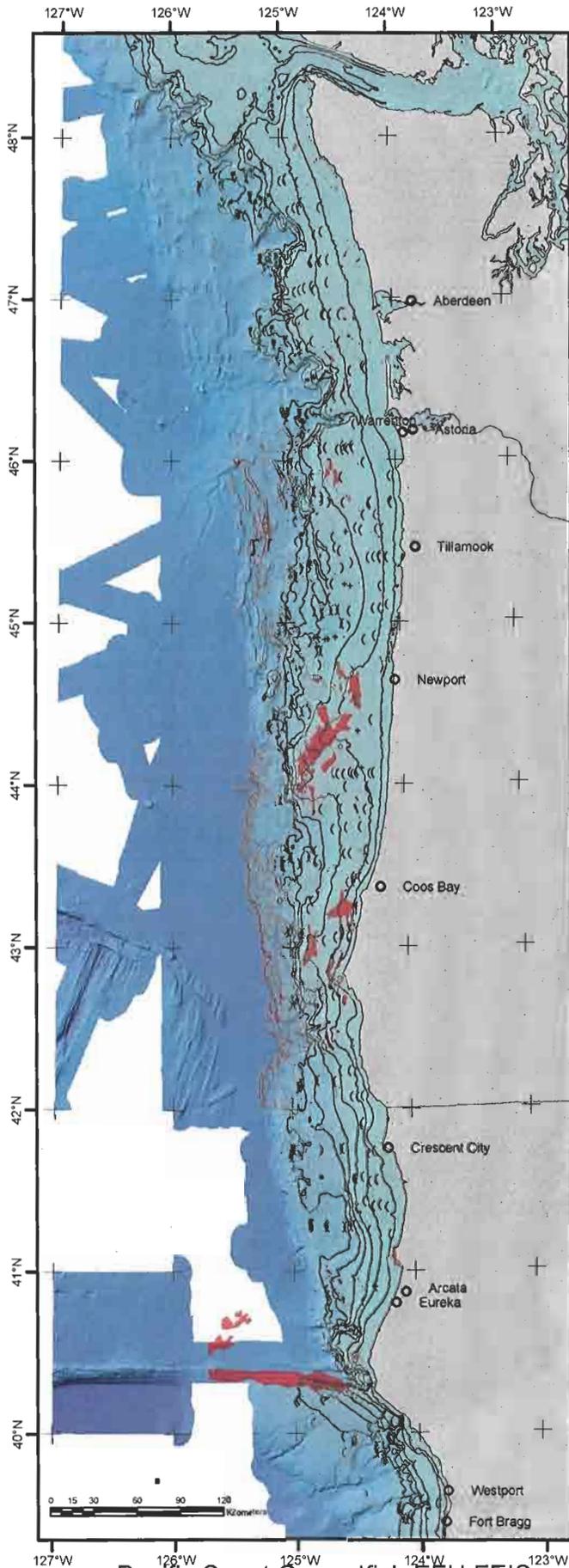
- Red shaded area: hard

Projection: Albers Equal Area Conic
Datum: North American Datum 1983
Standard Parallels: 32 and 48 degrees N
Central Meridian: 126 degrees W
Latitude of Origin: 40 degrees N

Data Sources:
 Northwest Fisheries Science Center -
 Fishery Resource Analysis & Monitoring Division
 Years: 2001-2003
 Alaska Fisheries Science Center -
 Resource Assessment & Conservation Engineering Division
 Years: 1977-2001
 Southern California Coastal Water Research Project -
 1994-Pilot Project Survey
 Pacific Coast Groundfish Essential Fish Habitat Project -
 Consolidated GIS Data, vol. 1, Physical and Biological Habitat
 April 2004
 NGLC Coastal Relief Model, vol. 6.7.8







Appendix B

Occurrences of Sea Pens and Whips (Order Pennatulacea) (Organized by Family) from Regional Surveys

Order, Family

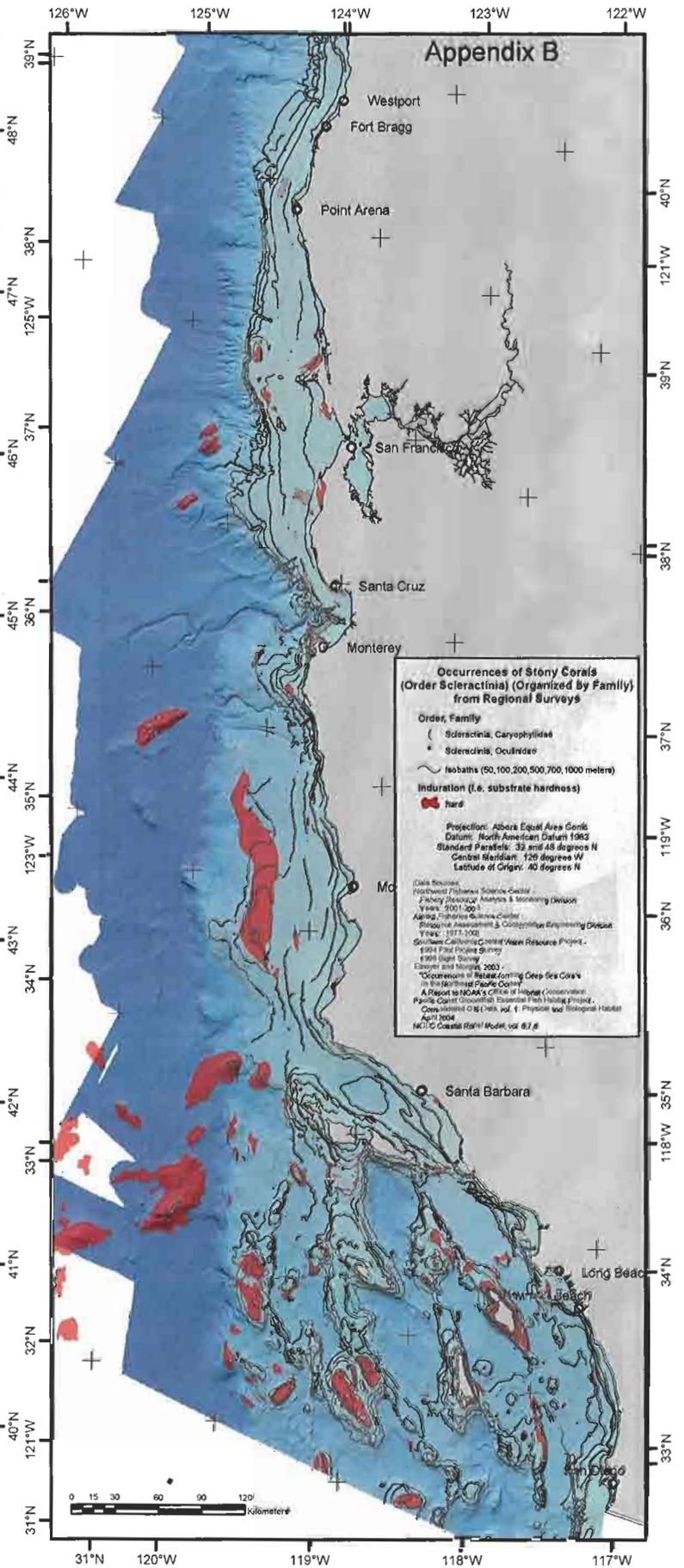
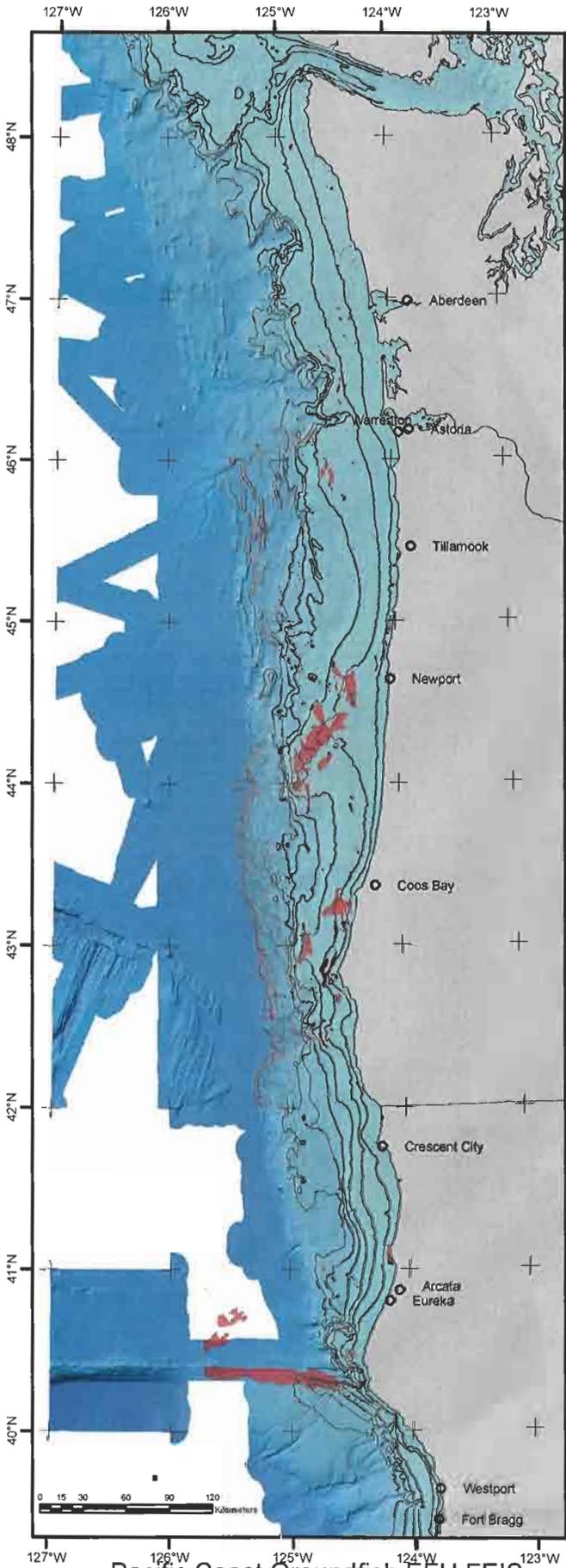
- ⌋ Pennatulacea, Anthoplidae
- ⌋ Pennatulacea, Pennatulidae
- ⌋ Pennatulacea, Umbelulidae
- ⌋ Pennatulacea, Virgulidae

~ Isobaths (50, 100, 200, 500, 700, 1000 meters)

■ hard (i.e. substrate hardness)

Projection: Albers Equal Area Conic
Datum: North American Datum 1983
Standard Parallels: 32 and 48 degrees N
Central Meridian: 126 degrees W
Latitude of Origin: 40 degrees N

Data Sources:
 Northwest Fisheries Science Center
 Fishery Resource Analysis & Monitoring Division
 Years: 2001-2002
 Alaska Fisheries Science Center
 Resource Assessment & Conservation Engineering Division
 Years: 1977-2001
 Southern California Coastal Water Resource Project
 1994 PSM Project Survey
 1998 Digital Survey
 Pacific Coast Geographical Essentials: Fish Habitat Project -
 Consolidated GIS Data, vol. 1: Physical and Biological Habitat
 April 2004
 NGDC Coastal Relief Model, vol. 6.7.8



Appendix B

Occurrences of Stony Corals (Order Scleractinia) (Organized by Family) from Regional Surveys

Order, Family

- (Scleractinia, Caryophyllidae
- Scleractinia, Oculinidae

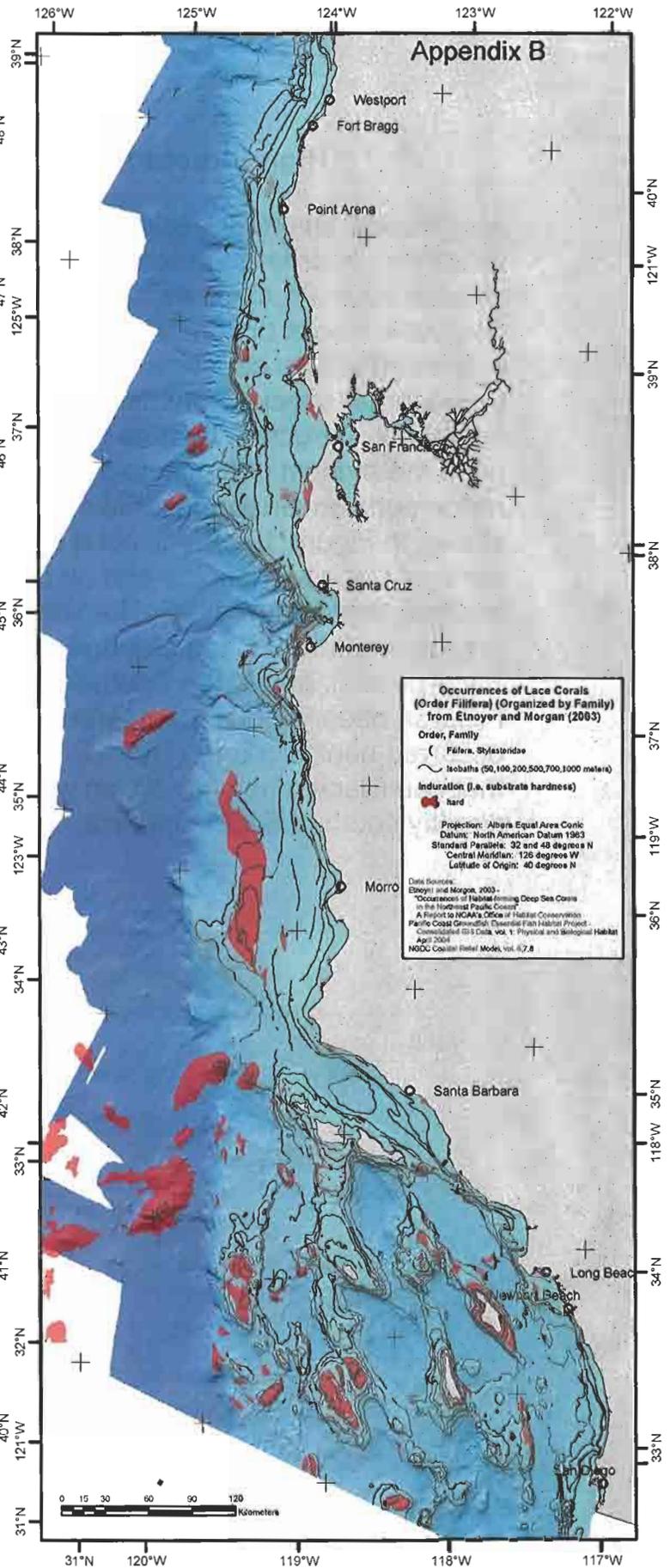
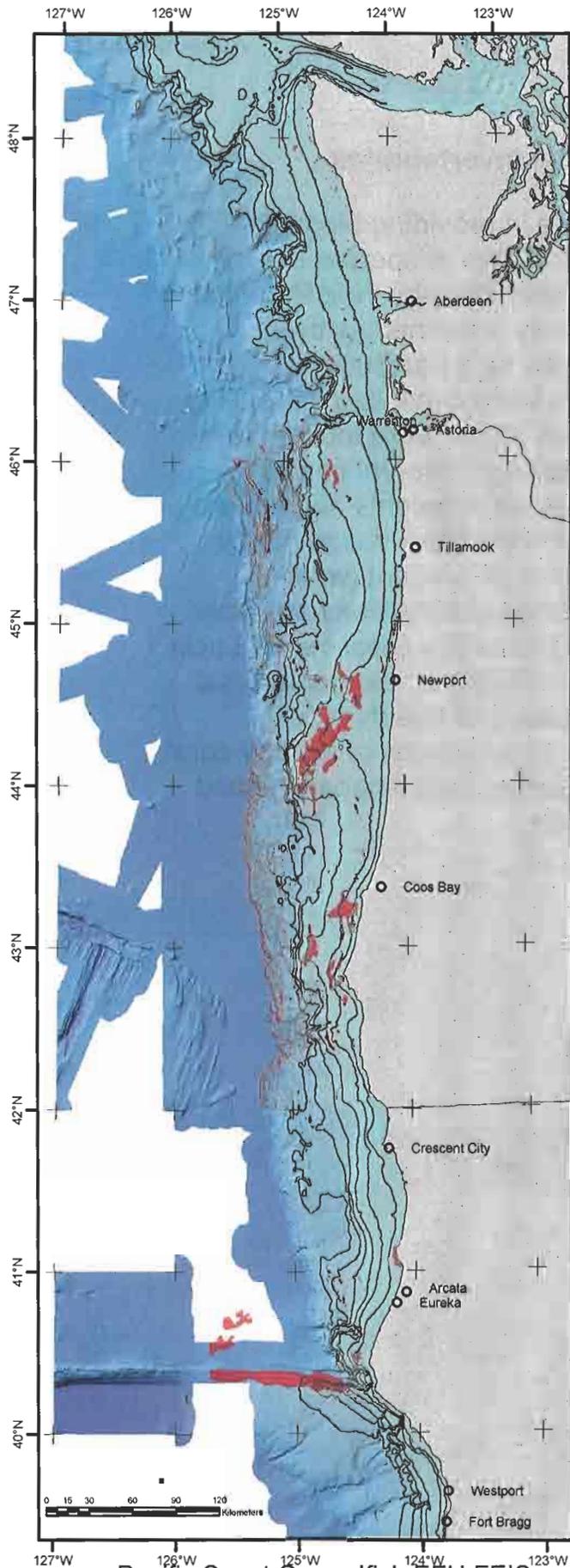
— Isobaths (50, 100, 200, 500, 700, 1000 meters)

Induration (i.e. substrate hardness)

- Hard

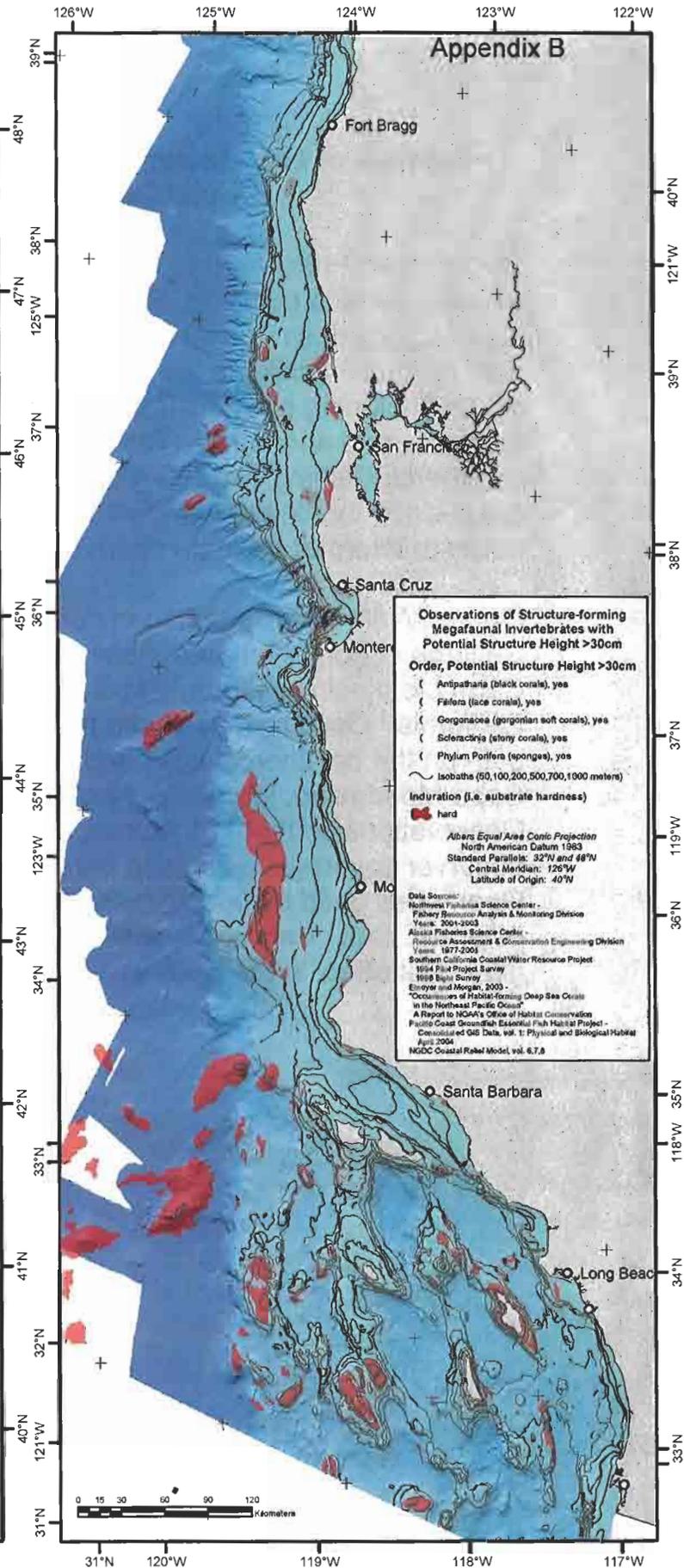
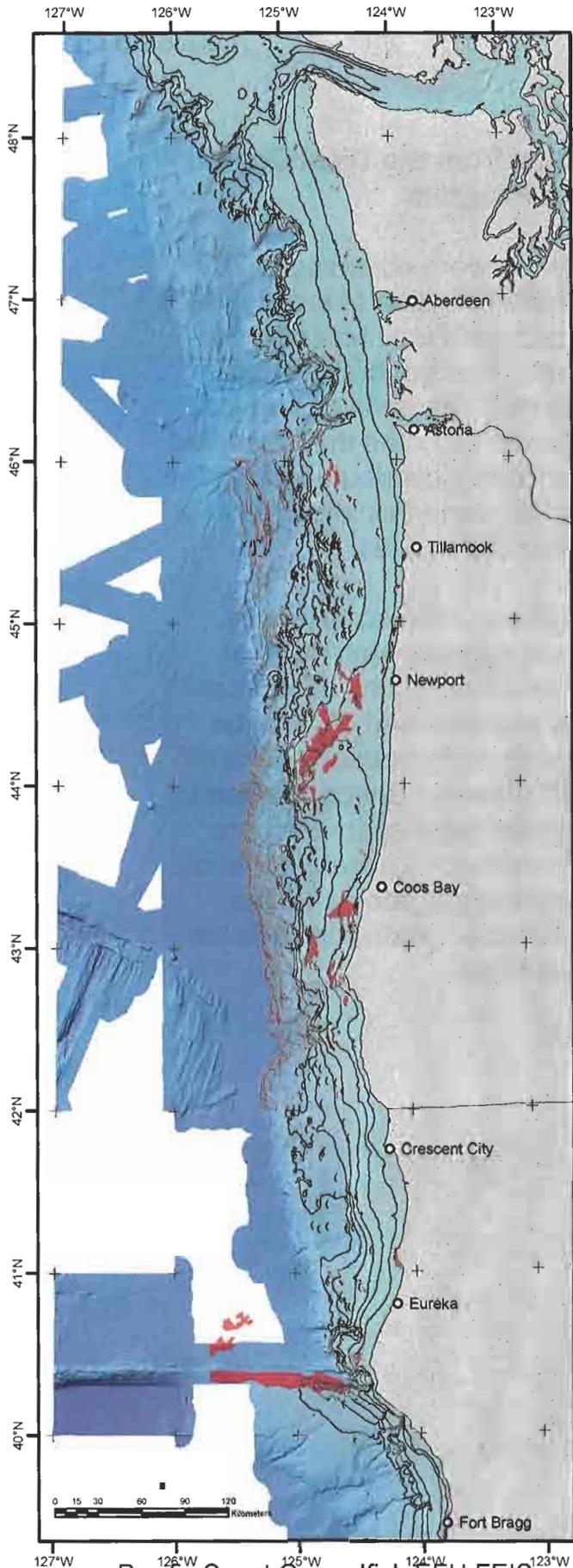
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Datum: North American Datum 1983
Standard Parallels: 32 and 48 degrees N
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Latitude of Origin: 40 degrees N

Data Sources:
 Northwest Fisheries Science Center
 Fishery Research, Analysis & Monitoring Division
 Years: 2001-2003
 Aging Fisheries Science Center
 Biological Assessment & Cooperative Engineering Division
 Years: 1977-2002
 Southern California Coastal Water Resource Project
 1994 Post Project Survey
 Canyon and Mouths, 2003
 "Occurrences of Retreating Deep Sea Corals in the Northwest Pacific Ocean"
 A Report to NOAA's Office of Habitat Conservation
 Pacific Coast Groundfish Essential Fish Habitat Project
 Completed 01/27/04, vol. 4: Physical and Biological Habitat
 April 2004
 NCI-C Coastal Bath Model, vol. 8.7.8



High Structure Megafaunal Invertebrates

Megafaunal invertebrates may play a role in providing biogenic structure. In order to determine the distribution of species like to provide such structure we have categorized them by their Potential Structure Height (PSH). PSH for this study is defined as the maximum known structure height obtained by a particular invertebrate species. Numerous experts were consulted to develop this index. Structure heights greater than 30 cm were thought to have the highest potential to provide habitat. Observations of megafaunal invertebrates that potentially reach heights >30 cm are shown in Figure 13. Black coral species were observed primarily north of Cape Mendocino and on Davidson Seamount (west-southwest of Monterey, California). Sponge observations are most prevalent north of Cape Mendocino, off Morro Bay (near Santa Lucia Escarpment), and in the Southern California Bight. Gorgonian and Filiferan observations are sparse but clusters of observations occurred near Monterey Bay. Only one observations of a stony coral that can reach a height >30 cm was recorded near Anacapa Island directly south of Santa Barbara, California.



Appendix B

Observations of Structure-forming Megafaunal Invertebrates with Potential Structure Height >30cm

Order, Potential Structure Height >30cm

- (Antipatharia (black corals), yes
- (Fafera (lace corals), yes
- (Gorgonacea (gorgonian soft corals), yes
- (Scleractinia (stony corals), yes
- (Phylum Porifera (sponges), yes

~ Isobaths (50,100,200,500,700,1000 meters)

Induration (i.e. substrate hardness)

Red hard

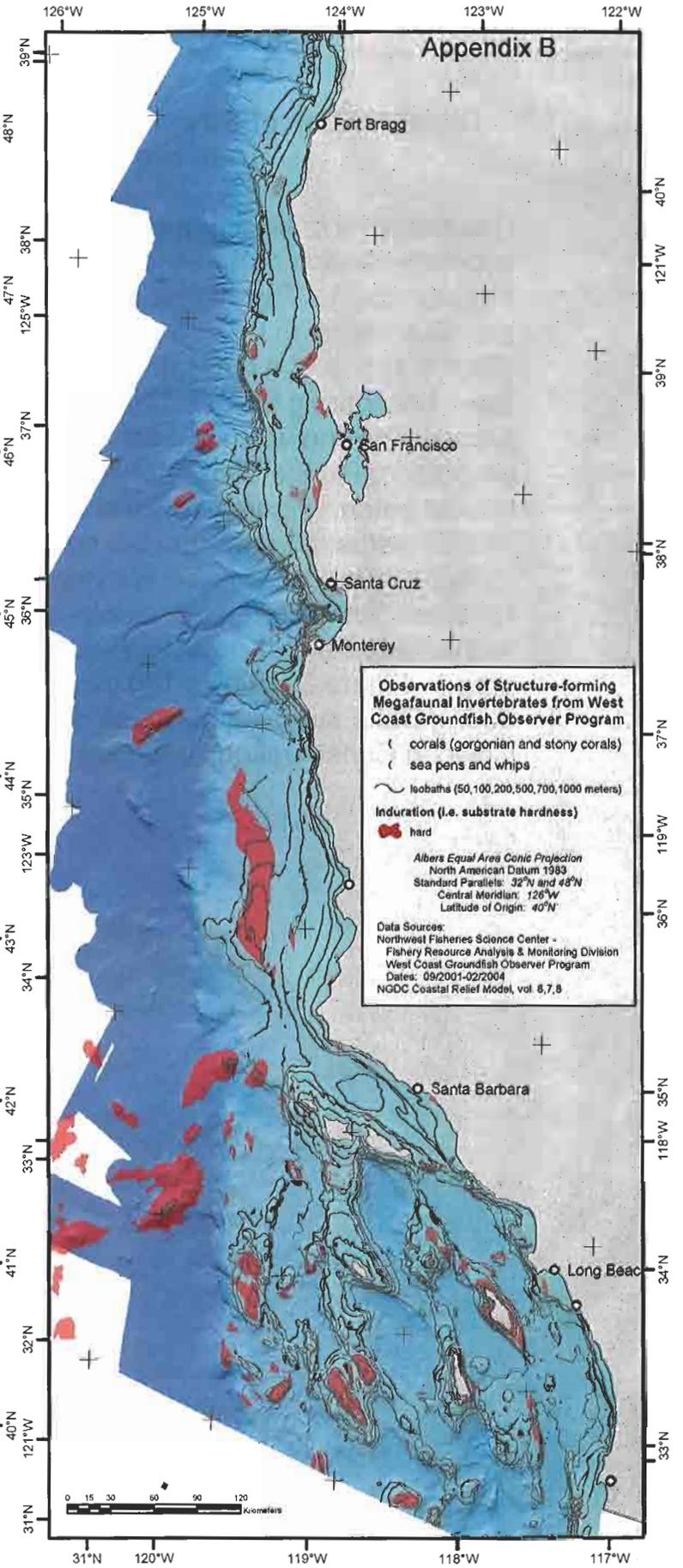
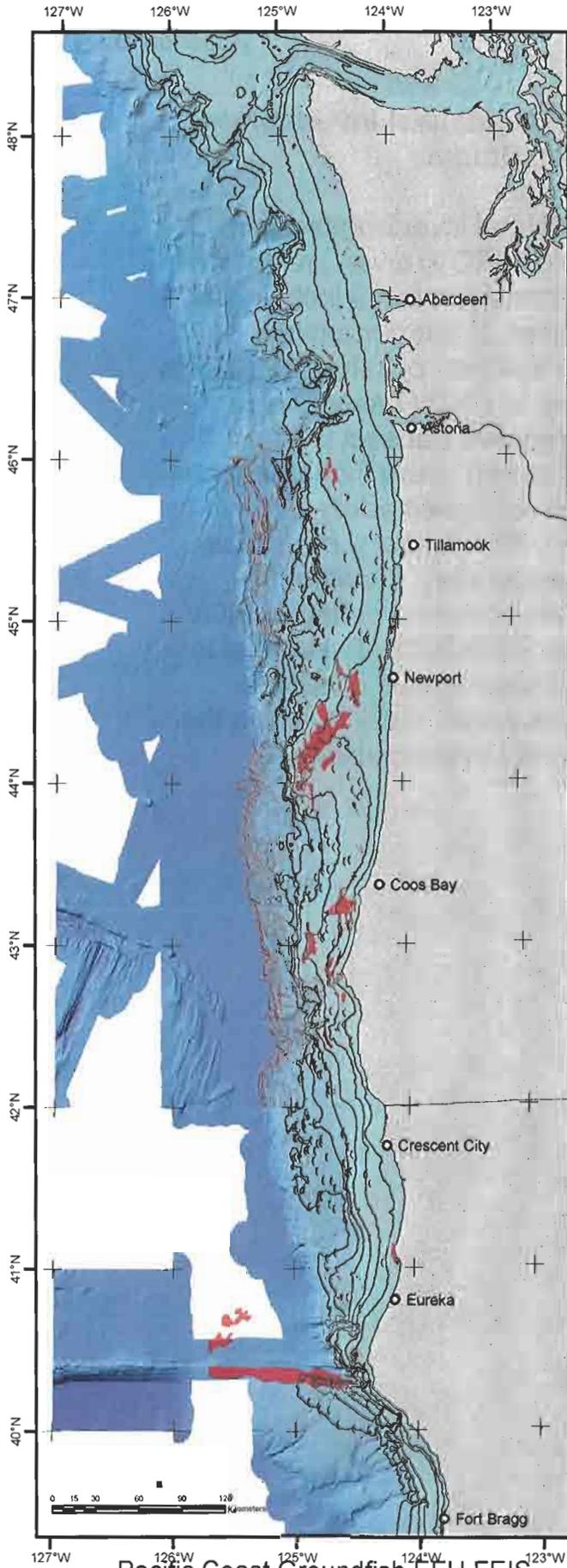
Albers Equal Area Conic Projection
 North American Datum 1983
 Standard Parallels: 32°N and 46°N
 Central Meridian: 126°W
 Latitude of Origin: 40°N

Data Sources:
 Northwest Fisheries Science Center -
 Fishery Resource Analysis & Monitoring Division
 Years: 2001-2003
 Alaska Fisheries Science Center -
 Resource Assessment & Conservation Engineering Division
 Years: 1977-2006
 Southern California Coastal Water Resource Project
 1994 Fish Project Survey
 1998 Bight Survey
 Enyover and Morgan, 2003 -
 "Occurrences of Habitat-forming Deep Sea Corals
 in the Northeast Pacific Ocean"
 A Report to NOAA's Office of Habitat Conservation
 Pacific Coast Groundfish Essential Fish Habitat Project -
 Consolidated GIS Data, vol. 1: Physical and Biological Habitat
 April 2004
 NGDC Coastal Relief Model, vol. 6.7.8

Catches of Megafaunal Invertebrates from the West Coast Groundfish Observer Program

Out of 12,411 observed hauls or sets, corals were observed in 239 and sea pens in 80 hauls. Since specific identification of invertebrates was not included in observer collection protocols until recently, the data currently available are categorized into four general groups: corals (including gorgonian and stony corals), sea pens and whips, sponges, and anemones (Table 1). It should be noted that observed commercial fishing effort has not been uniformly distributed along the coast since the beginning of WCGOP in 2001 and this affects our ability to interpret the data on invertebrate occurrences.

Figure 14 shows distribution of corals and sea pens occurrences. Records of gorgonian and stony corals are concentrated north of Cape Mendocino, with only about a dozen observations off central California. Occurrences of sea pens are concentrated off Oregon both on the continental shelf and slope, with limited observations off Cape Mendocino, Morro Bay, and one off Newport Beach, California. Observations south of Pt. Conception appear quite sparse, where observer coverage is focused primarily on the open access fisheries. Gear types used by open access fisheries include hook-and-line, pots, etc. that rarely catch sessile invertebrates, producing a visible gear bias effect in the Southern California Bight.



Observations of Structure-forming Megafaunal Invertebrates from High-Resolution Studies

Observations of structure-forming megafaunal invertebrates from submersible and remotely operated vehicle (ROV) dives are shown in Figures 15-21. This higher resolution information is not included in previous maps. Figure 15 portrays densities of two gorgonians (*Swiftia* spp. and a currently unidentified species) observed at Heceta Bank only during Delta submersible dives in 2002 (Tissot et al in prep.). The line width of each represented dive transect is proportional to the density of species observed over a homogeneous habitat patch. Figures 16-20 show observed densities of *Anthomastus ritteri* (gorgonian soft coral), *Florometra serratissima* (crinoid), *Gorgoncephalus eucinemis* (basket star), *Metridium farcimen* (anemone), and various sponges observed during all ROV and submersible dives at Heceta Bank in 2000-2002 (Tissot et al in prep.). Figure 21 shows 180 locations of black corals observed during Delta submersible dives on shallow water, rocky banks in the Cowcod Conservation Area (Yoklavich and Love unpublished).

Gorgonian Corals Observed at Heceta Bank from Delta Submersible in 2002

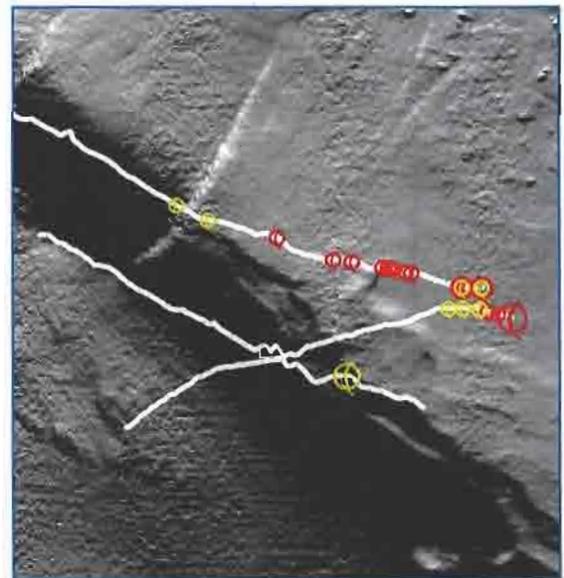
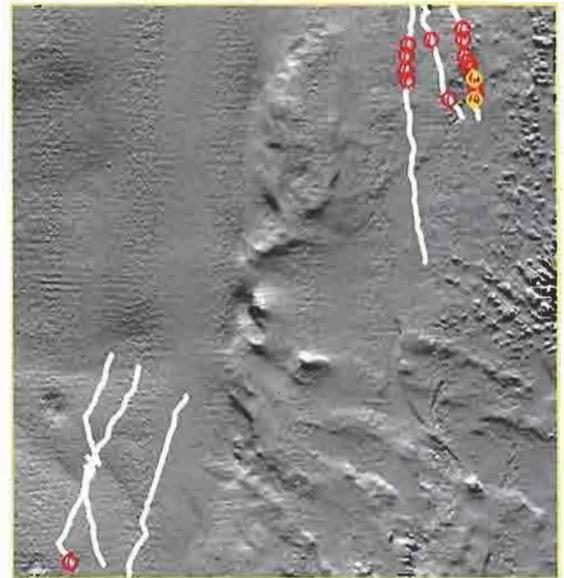
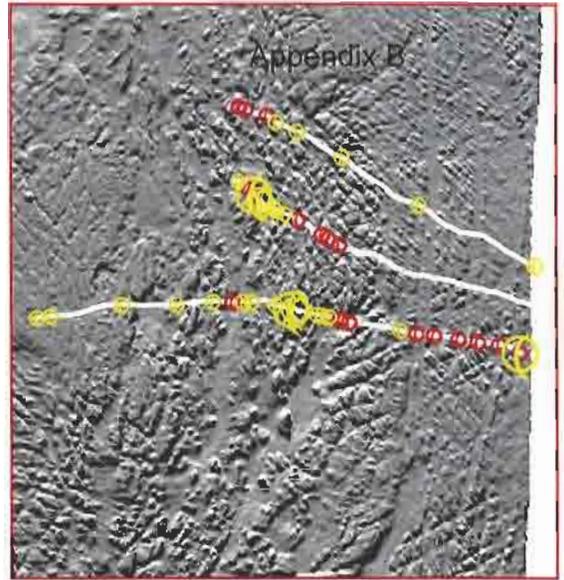
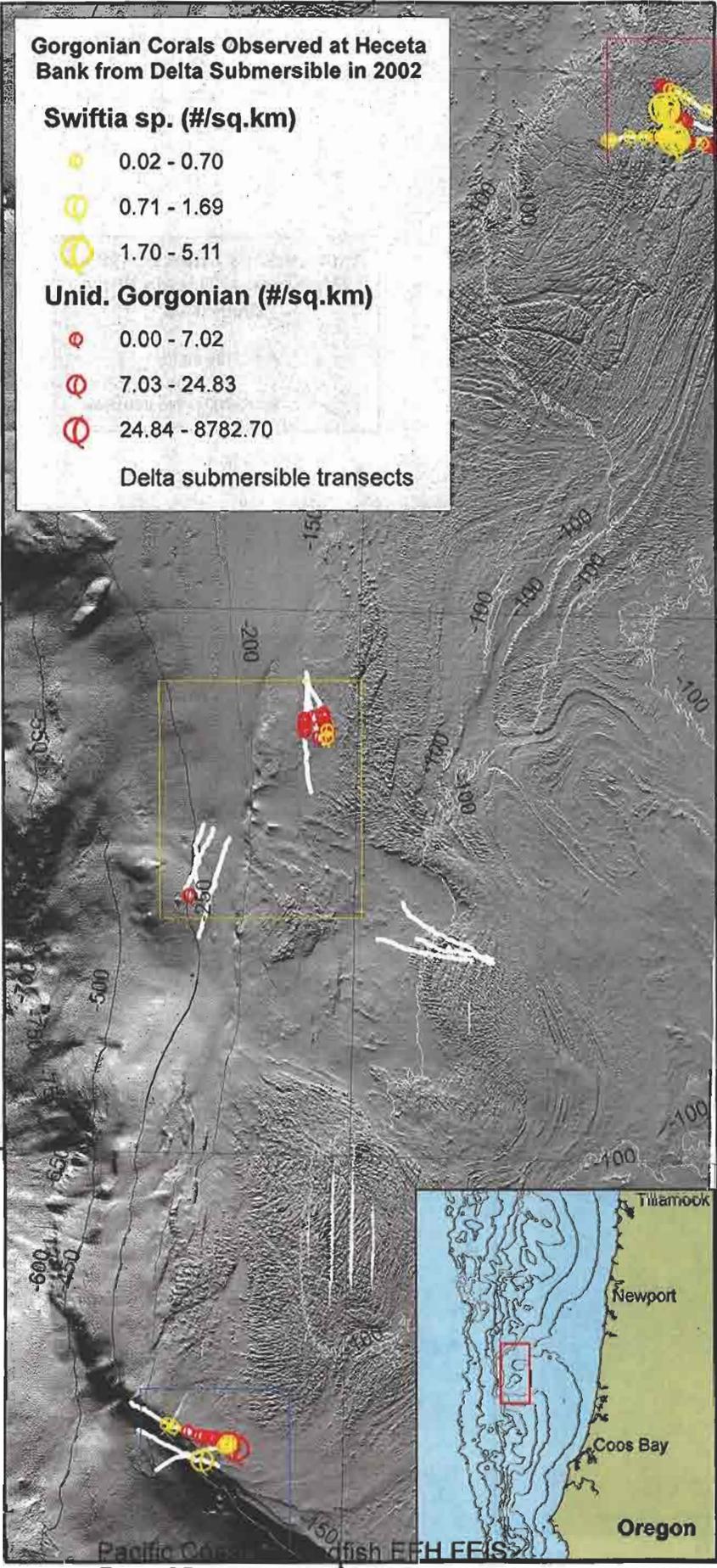
Swiftia sp. (#/sq.km)

- 0.02 - 0.70
- 0.71 - 1.69
- 1.70 - 5.11

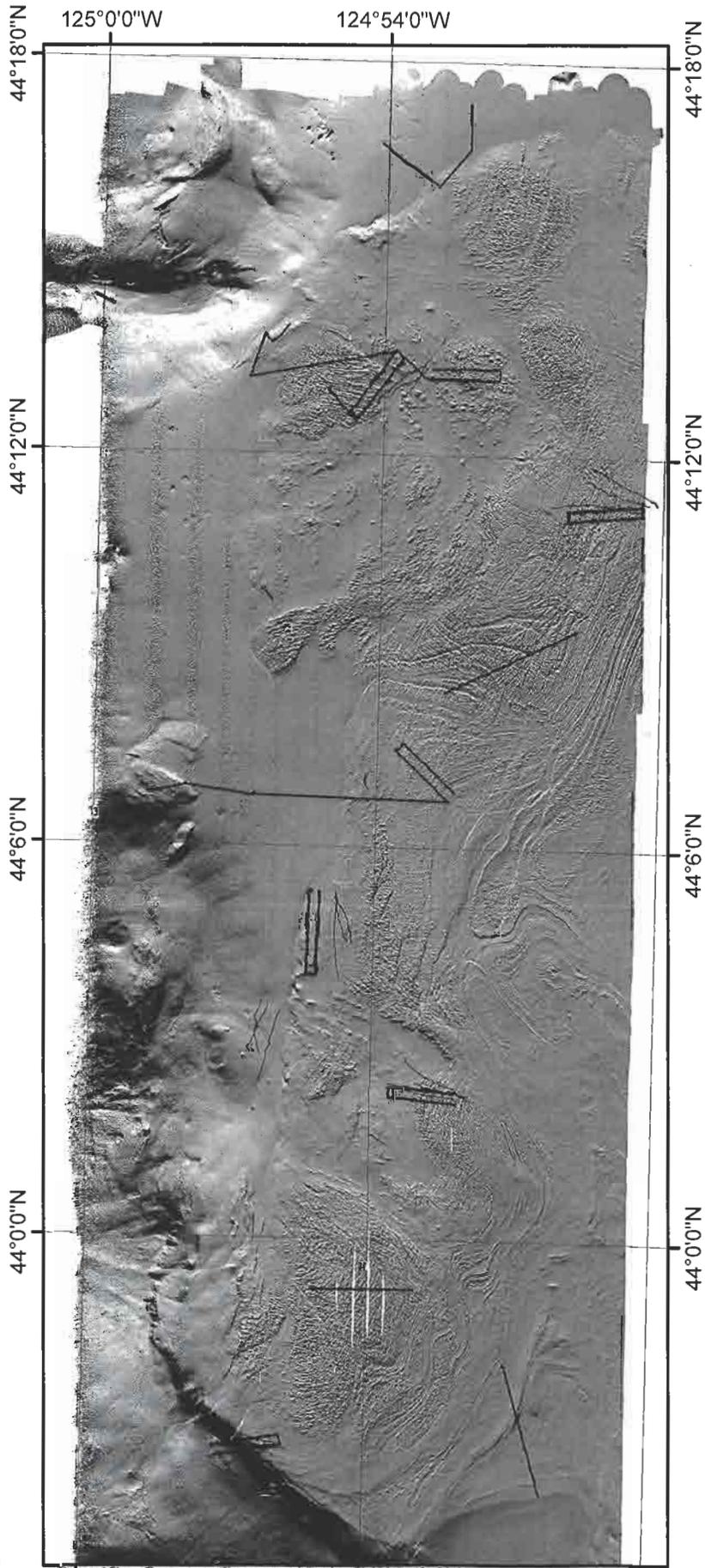
Unid. Gorgonian (#/sq.km)

- 0.00 - 7.02
- 7.03 - 24.83
- 24.84 - 8782.70

Delta submersible transects



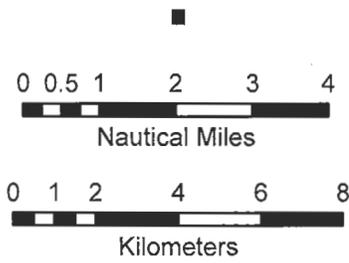
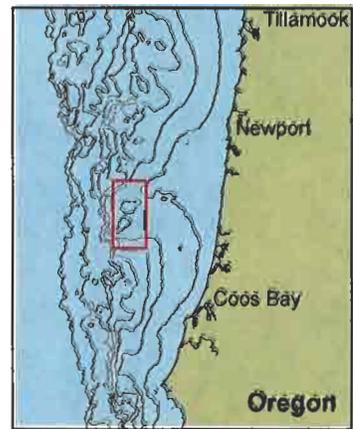
Appendix B

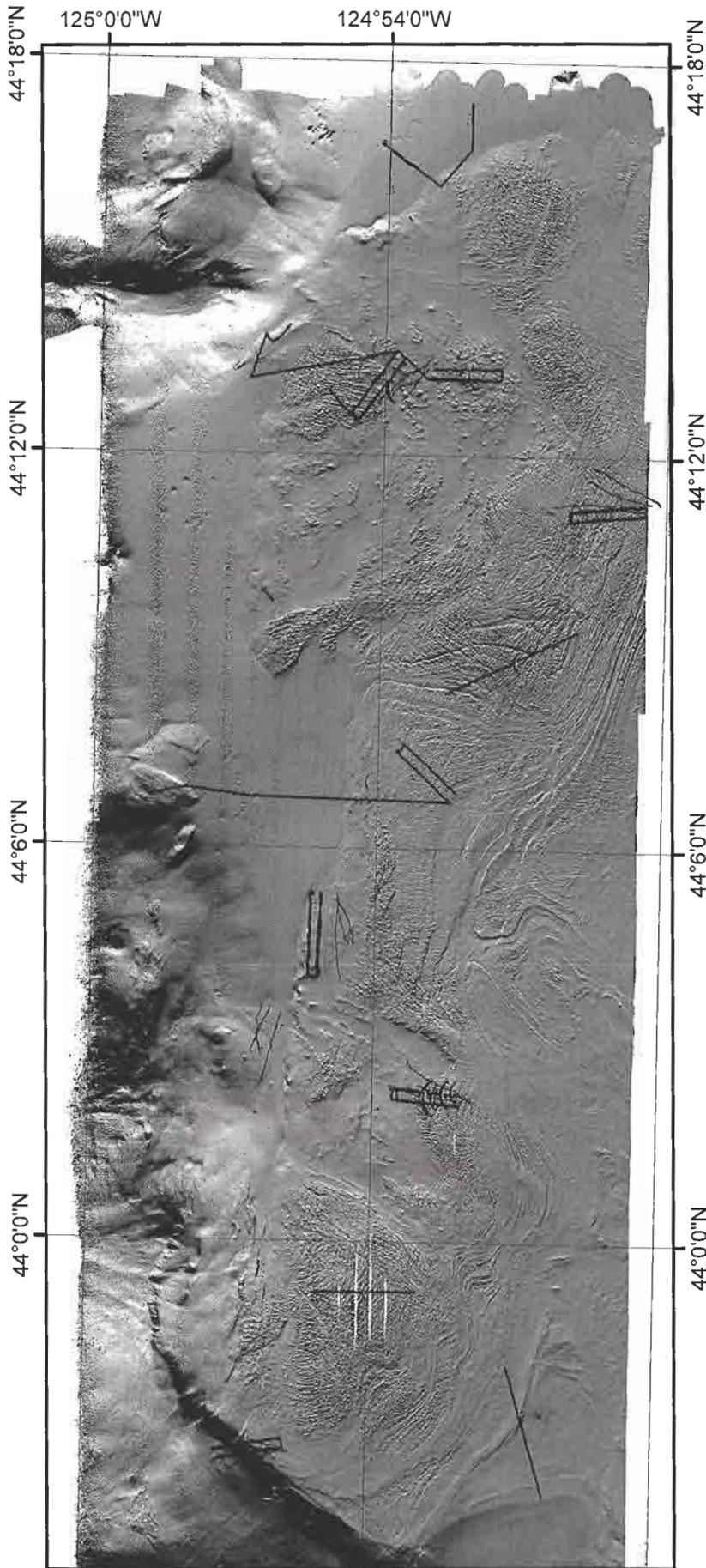


***Anthomastus ritteri* Densities
Observed at Heceta Bank
2000-2002**

(4.42 /100 sq.m

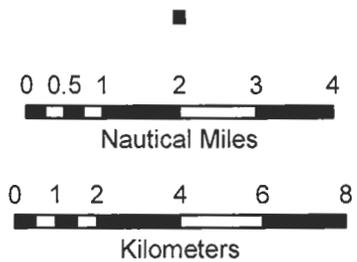
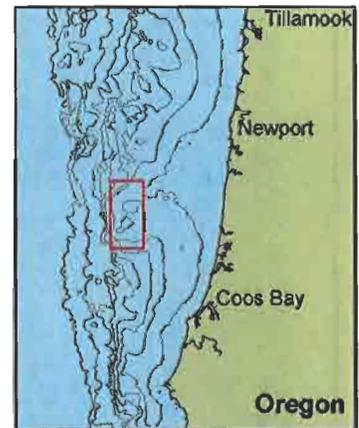
— 2000-2002 dive transects



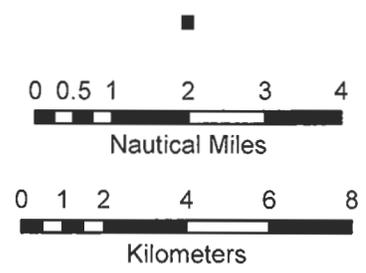
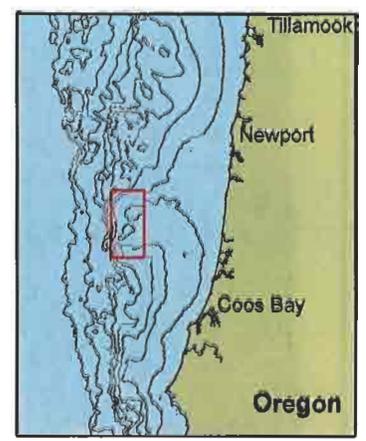
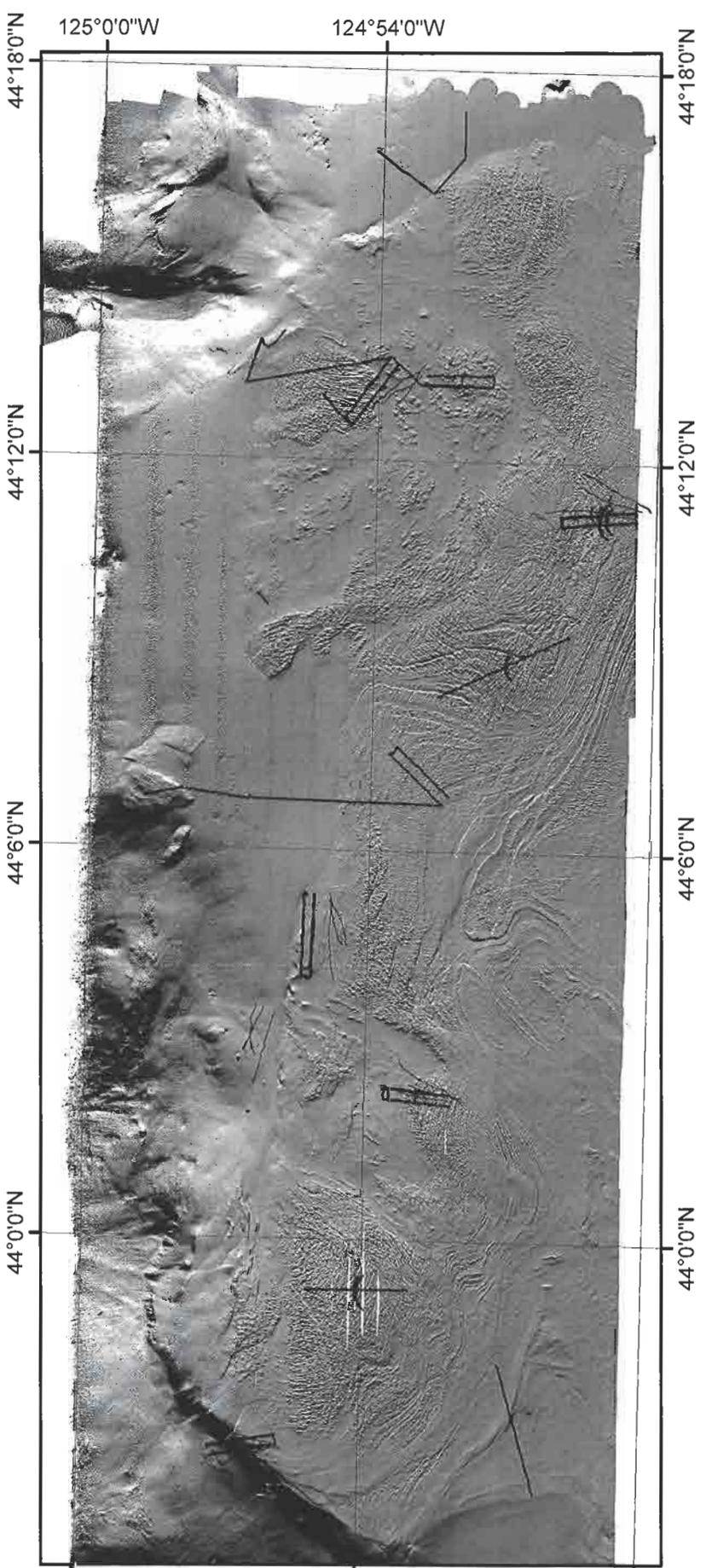
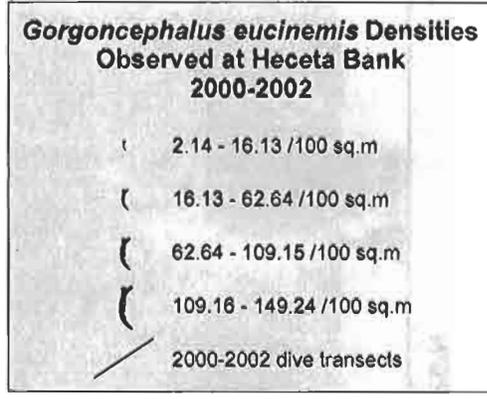


Appendix B
***Florometra serratissima* Densities
 Observed at Heceta Bank
 2000-2002**

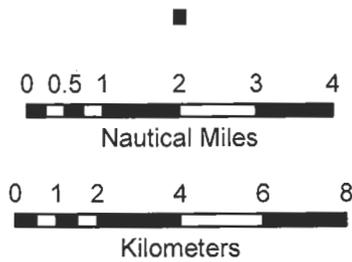
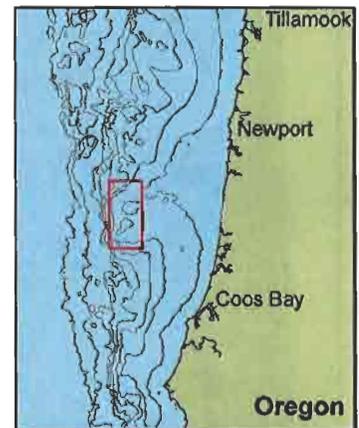
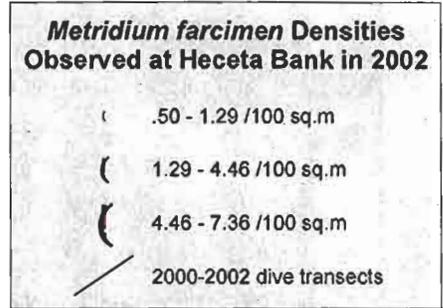
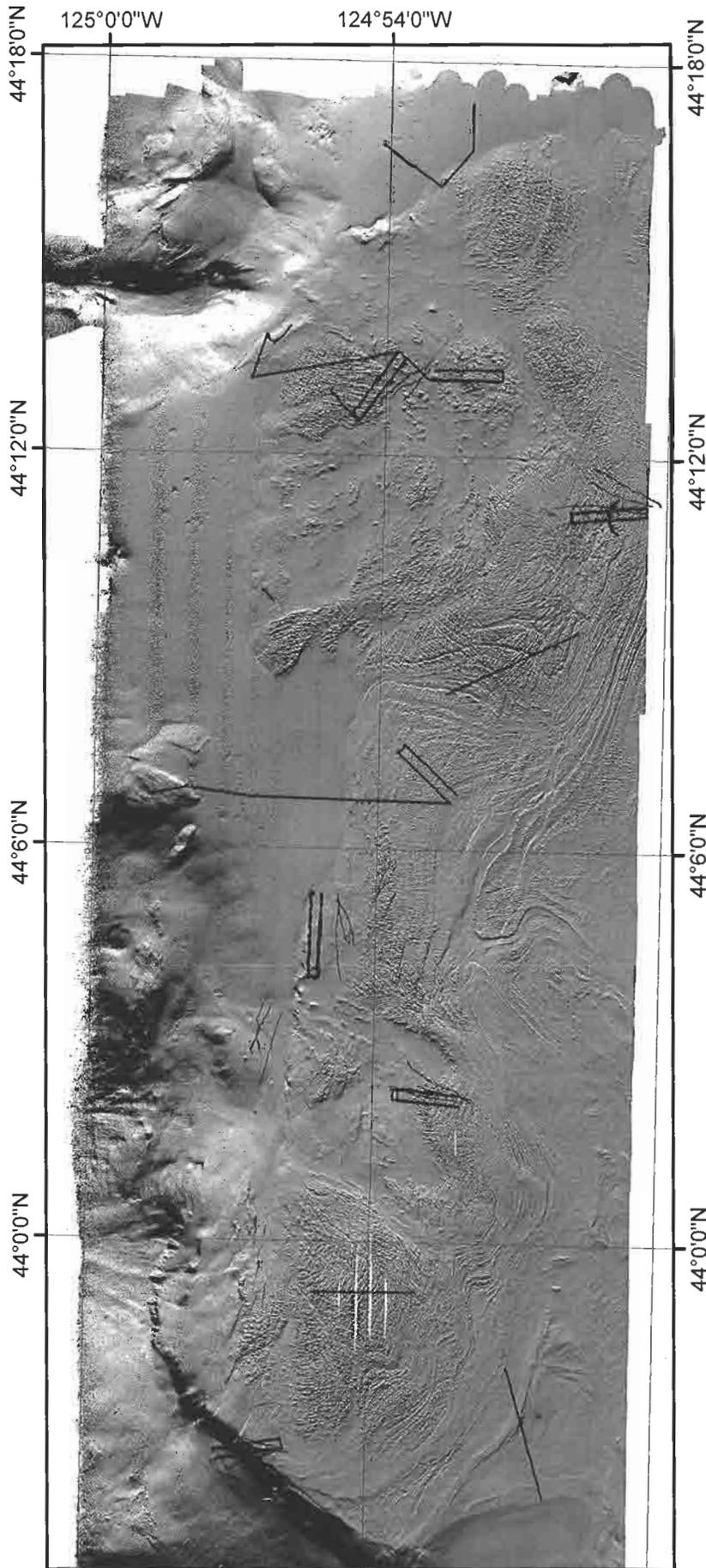
(0.10 - 5576.86 /100 sq.m
(5576.86 - 20,080.90 /100 sq.m
(20,080.90 - 34,584.94 /100 sq.m
(34,584.94 - 490,88.98 /100 sq.m
(49,088.99 - 52,261.39 /100 sq.m
/	2000-2002 dive transects

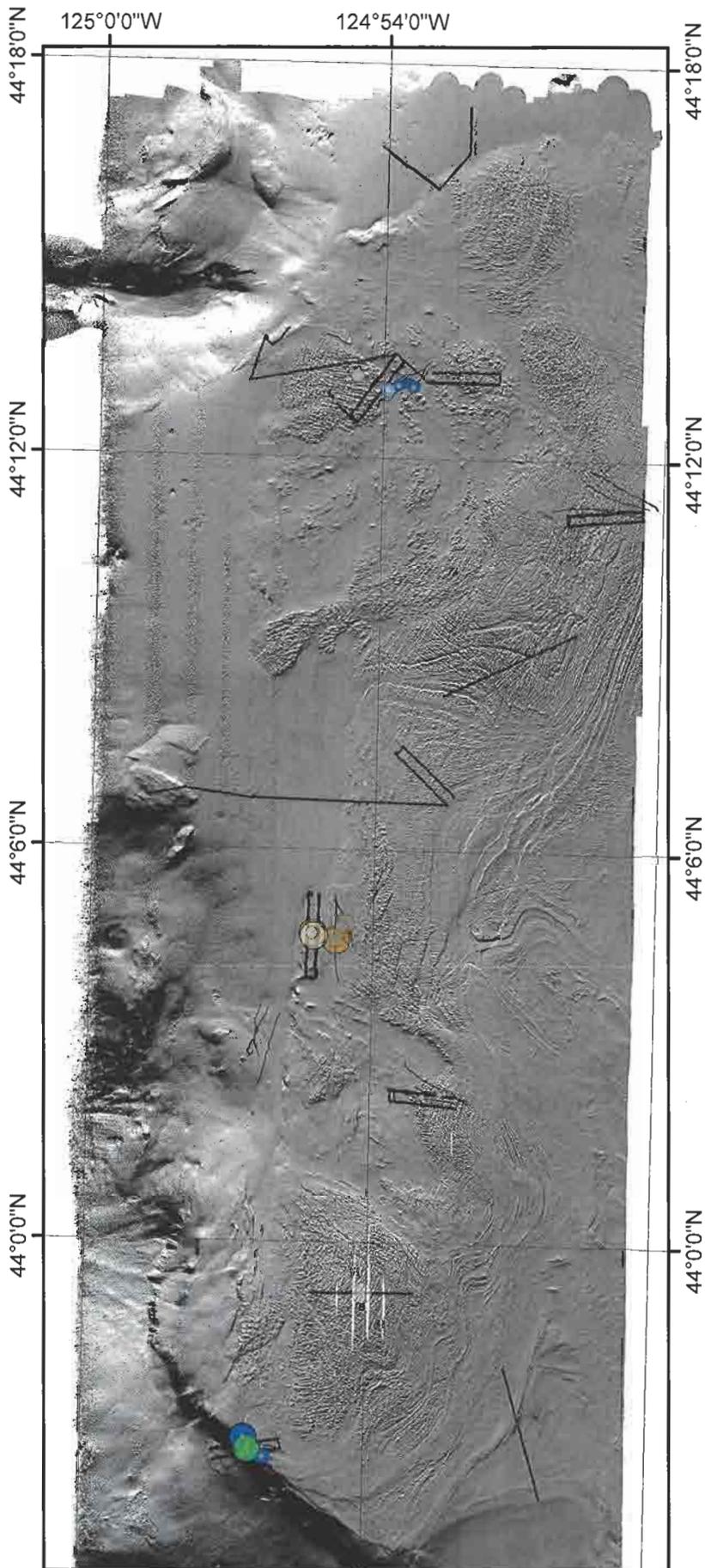


Appendix B



Appendix B





Various Sponge Densities Observed at Heceta Bank 2000-2002

Appendix B

Vase

- (0.35 - 52.55 /100 sq.m
- (52.55 - 104.99 /100 sq.m
- (104.99 - 157.42 /100 sq.m
- (157.42 - 167.26 /100 sq.m

Shelf

- (0.16 - 2.09 /100 sq.m
- (2.09 - 8.12 /100 sq.m
- (8.12 - 14.16 /100 sq.m
- (14.16 - 18.98 /100 sq.m

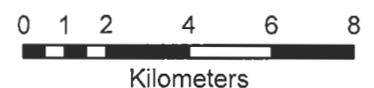
Flat

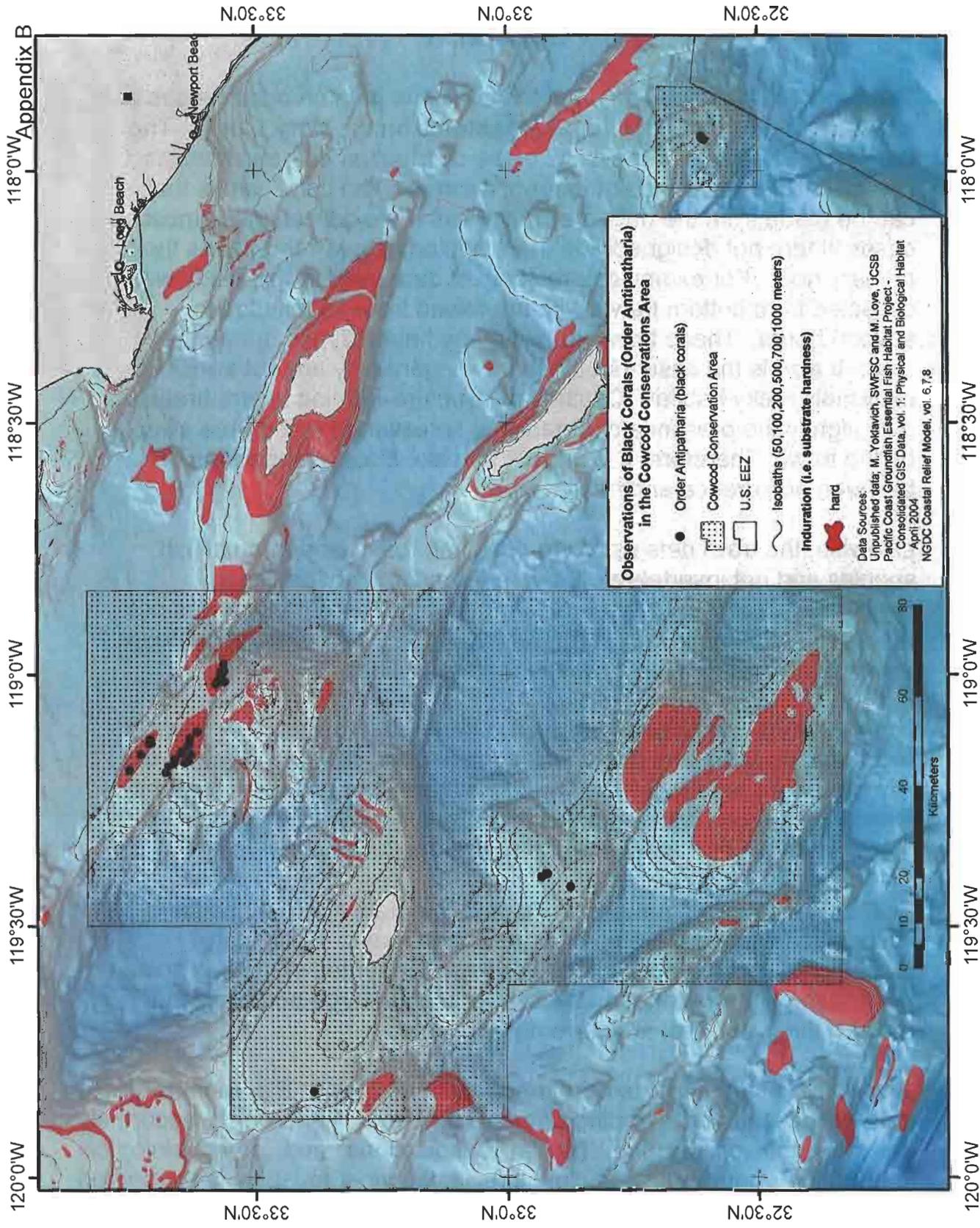
- (0.49 - 8.80 /100 sq.m
- (8.80 - 35.24 /100 sq.m
- (35.24 - 61.67 /100 sq.m
- (61.67 - 65.72 /100 sq.m

Foliose

- (0.74 - 9.97 /100 sq.m
- (9.97 - 168.27 /100 sq.m
- (168.27 - 326.57 /100 sq.m
- (326.57 - 484.87 /100 sq.m
- (484.87 - 736.30 /100 sq.m

2000-2002 dive transects





Discussion

The report summarized much of the available data on occurrences of structure-forming megafaunal invertebrates on the West Coast. The data provide a general overview of the distribution of these species and are based on a large number of records. The conclusions that can be made from the data are limited since the collections in most cases were not designed with the mapping of invertebrates as their primary goal. For example, a majority of data used in this study was collected from bottom trawls that are towed from 15 minutes to several hours. These trawls transit many habitat types during that time. It also is the case that these trawls generally are not transiting extremely rocky habitat. Catches of structure-forming invertebrates only signify the presence of organisms somewhere in the area swept by the trawl. Therefore, it is difficult to make clear associations between occurrence and habitat type.

Likewise, the trawl nets used are designed to target demersal fish species and not invertebrates. Since the gear is not designed specifically to collect invertebrates the fact that an organism was not recorded in the catch of a particular trawl does not necessarily mean the organism did not reside within the area swept.

Finally, the specific identifications are generally not available from most data sources and the dispositions (live vs. dead) of invertebrate samples were not recorded. Therefore there is uncertainty to specific identifications and if the samples represent live organisms and therefore those that are currently living in the area.

Fine scale surveys are the best method to obtain specific habitat associations and to develop high resolution maps. Such high-resolution data are very limited. We have presented some fine scale information here, but these studies represent a large portion of the data on this scale that are currently available.

Given the limitations of existing information it is clear that more targeted data collections and mapping efforts are needed. In order to accurately describe the occurrence, habitat associations and other biological information about these species, specific surveys must be implemented to provide both high resolution and medium resolution maps in

representative habitat areas. The NWFSC is currently making plans for such surveys.

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Tissot, B.N., W.W. Wakefield, N.P.F. Puniwai, J. Pirtle, K. York, and J.E.R. Clemons. In prep. Abundance and distribution of structure-forming megafaunal invertebrates, including cold-water corals, on Heceta Bank, Oregon, 2000-2002.

M. Yoklavich, SWFSC and M. Love, UCSB. Unpublished data.



